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Earth & Space Science News

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Jupiter's Aurora

AGU Medalists Honored

What Flows Beneath

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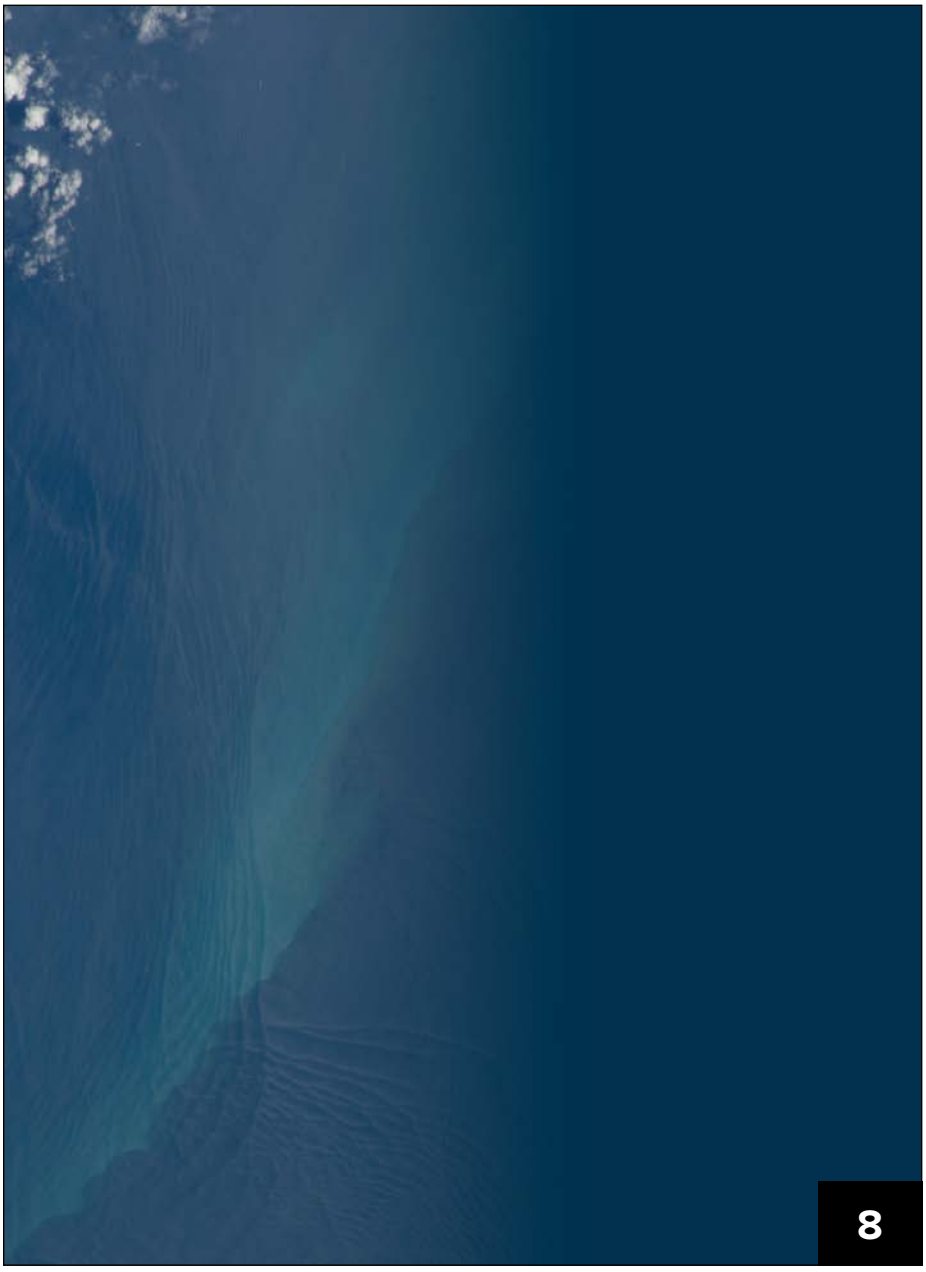

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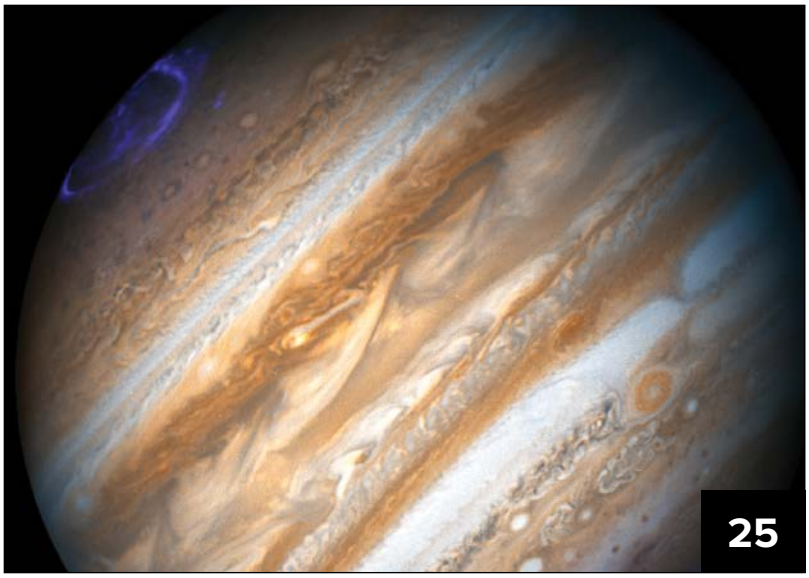

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Editor in Chief
Barbara T. Richman: AGU, Washington, D. C., USA; eos_ brichman@agu.org

Editors
Christina M. S. Cohen, California Institute of Technology, Pasadena, Calif., USA; cohen@srl.caltech.edu
Wendy S. Gordon, Ecologia Consulting, Austin, Texas, USA; wendy@ecologiaconsulting.com
Carol A. Stein, Department of Earth and Environmental Sciences, University of Illinois at Chicago, Chicago, Ill., USA; cstein@uic.edu
José D. Fuentes, Department of Meteorology, Pennsylvania State University, University Park, Pa., USA; juf15@meteo.psu.edu
David Halpern, Jet Propulsion Laboratory, Pasadena, Calif., USA; davidhalpern29@gmail.com

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Christine W. McEntee, Executive Director/CEO

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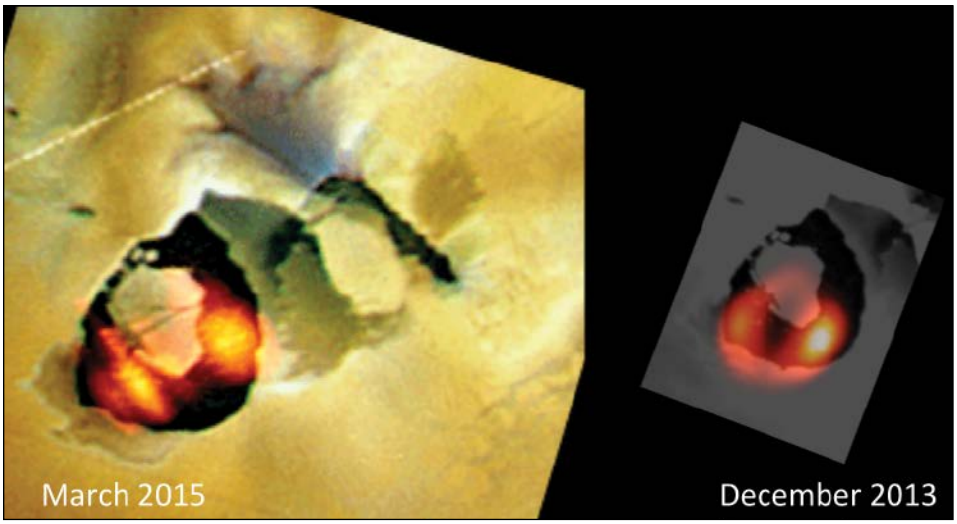
Jupiter's Europa Helps Earthlings See Sister Moon's Volcano

The enormous volcano Loki Patera dwarfs anything on Earth yet resides on tiny Jovian moon Io. Astronomers now report taking advantage of a chance alignment—the neighboring moon Europa passing in front of Io, as seen from Earth—to scrutinize the volcano and its huge lava lake with 40 times greater spatial detail than in past observations.

These highest-resolution images of Loki ever recorded from Earth may aid scientists to better answer questions about how this mysterious 200-kilometer-wide horseshoe-shaped lava feature formed and evolves.



LBTO

A new view (left) of the Loki Patera volcanic depression on Jupiter's moon Io reveals that hot spots in the volcano (red blobs with yellow centers) have shifted since the much lower resolution image (right) was captured in 2013. Each of these views of Loki overlays a 1970s visible light image of Io's surface onto a much newer infrared image from the Large Binocular Telescope (fiery-looking features in shades of red and yellow).

Fortuitous Occultation

Michael Skrutskie of the University of Virginia in Charlottesville and his colleagues were already set to examine Loki Patera last March with the Large Binocular Telescope, located in southeast Arizona, when they realized that a chance occultation by Io's neighbor could dramatically enhance the observations. They then adjusted the timing of their observations to take full advantage of Europa's temporary interposition.

During the first part of the occultation, known as the ingress, Europa progressively blocked larger regions of Loki Patera from view. Between successive telescope images, Europa cloaked about 2 additional kilometers of the volcano. The reverse occurred during egress, when Europa receded. By reducing the amount of Loki visible at any moment, Europa's passage between Earth and Io allowed the telescope to discern finer features of the volcanic terrain than it did in 2013, when Europa's assist was not available, Skrutskie said.

He described the findings on 12 November 2015 at the annual meeting of the American Astronomical Society's Division for Planetary Sciences in National Harbor, Md.

Shifting Hot Spots

The images reveal that the hot spots within Loki Patera have shifted position since 2013. As Skrutskie and his colleagues analyze more of the data, they may be able to make detailed temperature maps of the volcano, which could test models of how the hot spots develop, study collaborator Ashley Davies of NASA's Jet Propulsion Laboratory in Pasadena, Calif., told *Eos*.

In one model, Davies noted, blocks of crust form on the surface of the lava lake created by the volcano. As a block thickens and cools, it becomes less buoyant and finally sinks down to the bottom of the lake. Researchers suggest that these blocks of crust sink successively in a counterclockwise direction around an island in the middle of Loki Patera, taking about 1.5 Earth years to go completely around. The process should generate a systematic temperature distribution across Loki Patera, which may be apparent in the high-resolution data, Davies said.

"Loki Patera is one of the great wonders of the solar system," and the new observations "may give us the nuts and bolts of how this massive volcano works," he said.

By **Ron Cowen,** Freelance Science Journalist; email: rcowen@msn.com

Climate Change Is a Conservative Issue, British Minister Says

Eliot VanOtteren photography © American Enterprise Institute

United Kingdom foreign secretary Philip Hammond (left) speaks at the American Enterprise Institute (AEI) in Washington, D. C. He and AEI president Arthur Brooks (right) conversed in front of an audience.

Taking action to combat climate change "is the right thing to do, the conservative thing to do," United Kingdom foreign secretary Philip Hammond stated in a 10 November 2015 address at the American Enterprise Institute (AEI), a conservative think tank based in Washington, D. C.

Hammond said that tackling climate change is consistent with conservative values—including market-based solutions and less emphasis on regulations—which he argued can help to protect the environment without damaging the economy.

"The smart thing to do is to harness the power of the market to tackle the challenges of climate change," Hammond said in the talk (http://bit.ly/Hammond-AEI) timed a few weeks prior to the United Nations climate negotiations that took place in Paris in late fall. "If we don't lead, others will decide the way forward, and their solutions may not be conservative ones. But if we do take the lead, we can ensure the global response is founded on the force of markets, the power of technology, and the institutions of capitalism."

Choosing Prosperity and Safeguarding the Planet

The debate about how to deal with climate change has been dominated by people who opt to sacrifice economic growth and prosperity in order to meet the challenge, he said. "There are those on the left who have seen the need for action on climate change as a justification for large-scale mobilization, for a regulatory bonanza and a bigger state. If a purely regulatory approach was the answer, I have no doubt that economic growth would suffer," he argued. "I don't accept that we have to choose between our future prosperity and safeguarding the future of our planet. This is not a zero sum game. As conservatives, we choose both."

Hammond contended that appropriate market mechanisms include carbon pricing, which he said is in place in the United Kingdom and in line with conservative values. "Carbon pricing corrects a market failure—that we have allowed carbon dioxide emissions to be a free good to the polluter," he said. Accelerating the pace of innovation in green energy technologies is another winning strategy, according to Hammond.

The Economics of Climate Change

From an economic perspective, dealing with climate change can help to support the global low-carbon economy, which is already worth US$6 trillion with a 4%–5% annual growth rate, Hammond commented. He also pointed to the United Kingdom, where growth in the low-carbon sector is outpacing the economy as a whole.

Hammond acknowledged that action on climate change involves some hard choices and that some sectors, including coal, could be in for a difficult time. He called for careful thinking about how to manage the impact on people involved with those sectors. However, the costs of doing nothing on climate change "are potentially catastrophic," Hammond argued, noting that inaction could lead to a significant drop in global consumption and other environmental and health costs that cannot be easily quantified in economic terms.

Hammond said that tackling climate change means taking the same type of precautionary approach that U.S. president Ronald Reagan employed in the 1980s to deal with the problem of ozone depletion.

"The evidence in favor of taking action to curb carbon emissions has been steadily mounting for decades. Uncertainty about the exact effects of climate change or the role of man's activity in delivering it is not an excuse for inaction," he said. "In every other facet of life, we assess the risks and where the risk of occurrence is high and the impacts are potentially catastrophic, we act to mitigate and to prevent. Our approach to climate change should be no different."

A Market-Based Approach

In the United States, a market-based approach to tackling climate change has definite appeal, according to U.S. Department of Energy (DOE) secretary Ernest Moniz. He was asked by *Eos* about Hammond's remarks at an unrelated 13 November 2015 DOE briefing. Moniz said that in his view, "most of us believe ultimately that's where we want to go." But it requires cooperation with Congress, he added.

When President Barack Obama issued the White House Climate Action Plan in June 2013 (see http://bit.ly/POTUS-Climate-Plan), Moniz noted, the president said, "Look, we'd love to work with Congress on this, but we can't wait. And if Congress doesn't want to act now, we are going to go ahead with the authorities that we have."

In the meantime, the administration "has put together a pretty effective program, but it is sectoral by its nature," Moniz said, noting that the program includes a clean power plan and fuel standards for vehicles, among other measures. "If you really wanted to do an integrated economy-wide, market-based approach, we clearly need legislation for that."

By **Randy Showstack,** Staff Writer

Purple Hearts Honor Four Meteorologists Killed in World War II

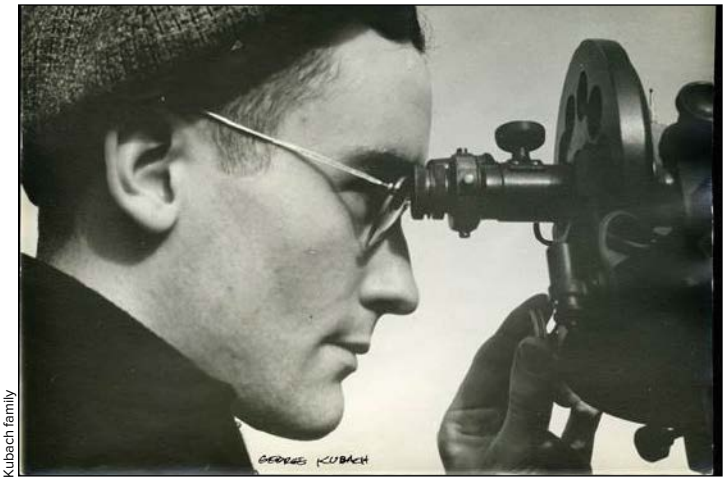
Submarines "are roaming the seas around where we are—like flies," Richard Fodor recalled his older brother Lester telling him about the North Atlantic area where he was stationed on the USS *Muskeget*. "I'm not too sure about this ship," Lester confided in his brother. Richard Fodor, who last saw his brother during a visit home to Cleveland, Ohio, in May 1942, recalls Lester telling him that the former Great Lakes freighter was "pretty clunky."

A few months later, on 9 September, German submarine U-755 torpedoed the ship at its location at Weather Station No. 2 (52°N, 42°W). Lost at sea were 107 enlisted men, 9 commissioned officers, 1 public health service officer, and the 4 weathermen: Luther Brady, George Kubach, Edward Weber, and Lester Fodor.

"I think about my brother every day," Richard Fodor told *Eos*, following a 19 November 2015 ceremony at the U.S. Navy Memorial in Washington, D. C., where the U.S. Coast Guard posthumously awarded Purple Heart medals to the four civilian meteorologists. (The USS *Muskeget* was a Coast Guard vessel.) The occasion marked the first time that U.S. Weather Service employees have received the Purple Heart, a U.S. combat decoration for those killed or wounded in action (see http://bit.ly/Purple-Heart-Ceremony).

NOAA

National Weather Service director Louis Uccellini (left) and National Oceanic and Atmospheric Administration deputy undersecretary for operations vice admiral Michael Devany (right) present a commemorative plaque to Richard Fodor. Fodor's older brother Lester died in September 1942 following a U-boat attack while serving as a weather observer for the U.S. Weather Bureau.



Kubach family

George Kubach, one of the four civilian meteorologists posthumously honored on 19 November 2015 with the Purple Heart. Kubach served as an assistant weather observer with the U.S. Weather Bureau.

Critical to Winning the War

At the ceremony, the National Oceanic and Atmospheric Administration (NOAA) also presented the meteorologists' families with commemorative plaques. The weathermen had worked for the U.S. Weather Bureau, the predecessor to the U.S. National Weather Service (NWS), which today is part of NOAA.

"Weather observation was a critical element in the Battle of the Atlantic," remarked NOAA director of maritime heritage James Delgado at the ceremony. "Both sides [in the war] expended considerable effort to establish weather stations and post weather ships in the North Atlantic. And, in consequence, weather ships and stations became strategic targets for both sides."

> "Weather ships and stations became strategic targets for both sides" during World War II.

The war took place before satellite systems, GPS, and the Weather Channel, he noted. Weathermen, he said, performed their duties in miserable circumstances: cold, wet, the ship pitching and rolling on the high seas. "In the midst of merely holding on—one hand for yourself, one hand for the ship—to then be looking through a sextant to try to make a weather siting as a balloon goes up, I mean [that is] incredible dedication," Delgado told *Eos*.

The job of calling relatives to tell them about the Purple Heart ceremony had fallen to Delgado. Phoning Richard Fodor, he recalled, had brought tears to his eyes. "He asked me at the end of the call if his brother had made a difference," Delgado related. "Yes, his brother made a difference."

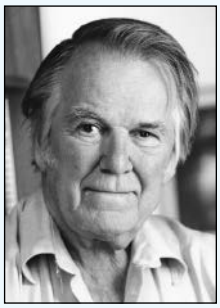
Safe Transit

NWS director Louis Uccellini stressed that weather data collected by meteorologists on the *Muskeget* and other ships were vital for safe transit on water and in aircraft over the Atlantic. He told *Eos* that weather forecasts based on observations from other ships provided critical information to convince the Allies to delay D-day from 5 June to 6 June.

Uccellini also drew a parallel between the lost weathermen and the efforts of their modern-day counterparts. Those who study the weather and make forecasts that could save lives and property "are about as dedicated individuals as you'll ever find," he said.

By **Randy Showstack,** Staff Writer

F. Curtis Michel (1934–2015)



Jeff Fitlow, Rice University

F. Curtis Michel

Professor emeritus Curt Michel died on 26 February 2015 at the age of 80. As we mourn the personal loss, we celebrate the career of our esteemed colleague.

Curt received his Ph.D. from the California Institute of Technology (Caltech) in January 1962, with a thesis in experimental nuclear physics, under the direction of Thomas Lauritsen, William Fowler, Charles Barnes, and Felix Boehm. Following a research fellowship at Caltech, he became one of the four founding faculty members of the nascent Department of Space Science at Rice University in 1963. He was instrumental in setting the tone for the new department through a comprehensive and challenging course curriculum and a devotion to cutting-edge research.

An Air Force jet pilot veteran with 500 hours of flight time, Curt was selected by NASA as one of six scientist-astronauts in 1965. He left that program in 1969 when it became evident that he would not be selected for spaceflight. He returned full time to Rice, where he chaired the renamed Space Physics and Astronomy Department from 1974 to 1979 and was named the Andrew Hayes Buchanan Professor of Astrophysics in 1974.

World Traveler

Curt traveled widely. He was a visiting scientist at the Institute of Theoretical Astronomy in Cambridge in the summers of 1970 and 1972, a member of the Institute for Advanced Study at Princeton in 1971–1972, and a Guggenheim Fellow at Ecole Polytechnique in 1979–1980. He was an Alexander von Humboldt Scientist at the Max-Planck-Institut für Kernphysik in Heidelberg in 1983–1984 and at the Max-Planck-Institut für Extraterrestrische Physik in Garching in 1994. He worked at the Solar Terrestrial Environment Laboratory at the University of Nagoya as a visiting professor in 2001–2002. Before embarking on each visit, Curt trained himself in the local language and culture.

But Houston was his home, and Curt was a familiar intellectual presence on the Rice campus. He was an early and active member of Scientia, an Institute for the History of Science and Culture. His primary research field was high-energy astrophysics, in particular, the physics of pulsars. He wrote a definitive book on that subject, *Theory of Neutron Star Magnetospheres* (University of Chicago Press, 1991). But his interests and his talents were not confined to a single topic.

Scientific Pioneer

He collaborated widely and contributed significantly to a variety of studies, ranging from solar wind structure and dynamics to solar wind interaction with the Moon and the unmagnetized planets Venus and Mars to the magnetospheres of Earth and Jupiter and the rings of Saturn. He pioneered the theoretical study of nonneutral plasmas observed in the laboratory and thought to exist in astrophysical settings. He also pioneered the transfer of knowledge from solar system plasma studies to astrophysics, in particular the revolutionary concept, now gaining acceptance, that neutron stars have disks and/or planets that play observable roles in pulsar phenomenology. Most recently, he argued persuasively that the Voyager 1 spacecraft did indeed leave the heliosphere and enter interstellar space in August 2012, a point that was controversial at the time. Curt searched for the truth and never feared controversy.

> Curt was a familiar intellectual presence on the Rice campus.

Powerful Roles

Curt retired from the Rice teaching faculty in 2000 but continued as an active researcher and an indispensable mentor until the end of his life. We close with a selection of unattributed quotes extracted from the many tributes that we received from former colleagues and students. These messages offer insight into the powerful roles Curt played in so many lives, as scientist, teacher, mentor, colleague, and friend:

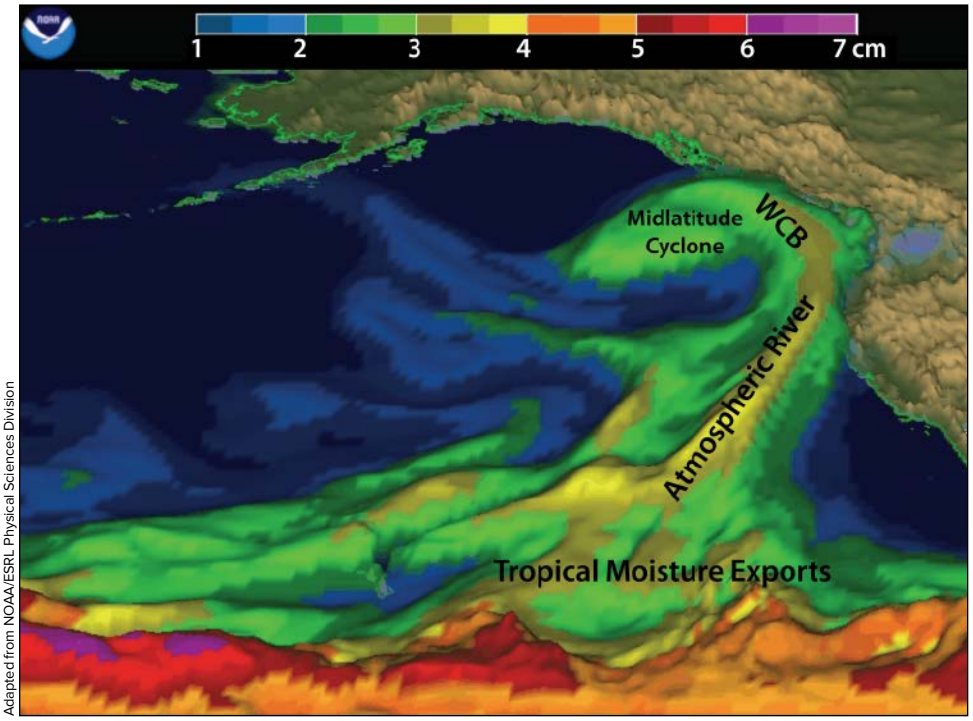
- I am not alone in considering him the smartest guy in the room. Curt was a joy to be around—insightful and able to explain his novel thoughts in clever ways. He was the source of imaginative, useful ideas that he delivered with humor and panache. [From a colleague]
- He taught me how to cut through the obfuscation and drive straight to the heart of a physics problem, and to do so with grace, good will, and good humor. I will never forget those lessons, or the gentleman who taught them by his good example. [From a student and colleague]
- He was one of the smartest people I have ever known. His knowledge of physics was amazing. He is most famous for his work in astrophysics, particularly pulsars, but he somehow also mastered nuclear physics, general relativity, plasma physics, space science, numerical methods, and data analysis. He could do it all. [From a colleague]
- I think the best lectures I heard at Rice were in Curt's general relativity course. Someone asked him how gravitational waves were created. He said one way would be for a mass, say a star, to disappear. When asked how that could happen, Curt said: "Well, you've got this dragon in another universe that reaches through and goes Snap!" [From a student]
- Curt could stand at the blackboard with a piece of chalk, arm dangling vertically. With a single sweeping motion somehow involving his shoulder, he could repeatedly draw the most perfect freehand circles I have ever seen. Never have I seen another example of that amazing skill. [From a student]
- He was a wonderful man, clever, inspired, provocative, funny, a great storyteller…, a mentor, and a gentleman. [From a colleague]

Curt is survived by his wife, Bonnie Hausman; his son, Jeffrey Michel, with grandsons Brent and Gregory; and his daughter, Alice Michel, with grandson Dexter Allen.

By **Paul A. Cloutier, Alexander J. Dessler, Thomas W. Hill,** and **Richard A. Wolf,** Professors Emeriti, Rice University, Houston, Texas; email: hill@rice.edu

Setting the Stage for a Global Science of Atmospheric Rivers

Atmospheric Rivers Workshop
La Jolla, California, 15–17 June 2015



Adapted from NOAA/ESRL Physical Sciences Division

Fig. 1. This depiction of an atmospheric river, interacting with West Coast mountains and a midlatitude cyclone over the northeast Pacific on 5 February 2015, provides an example of approximate locations of associated tropical moisture exports and a warm conveyor belt (WCB). The color scale gives the liquid-water equivalent of the water vapor content for each location.

Atmospheric rivers are important mechanisms for transporting water vapor through the atmosphere outside the tropics. These long, narrow, transient corridors occur at low altitudes just ahead of the cold front in midlatitude cyclone systems. These rivers in the sky stitch together the components of the extratropical water cycle by providing large-scale horizontal water vapor transport.

Scientists' understanding of the evolution, characteristics, geographic distribution, and hydrologic impacts of atmospheric rivers (ARs) in western North America, South America, and Europe has grown explosively in recent years. In June, experts from around the world met in La Jolla, Calif., to survey the state of atmospheric river science.

A highlight of the workshop was discussions of the relationships among ARs, warm conveyor belts (WCBs), and tropical moisture exports (TMEs). These components of large-scale water vapor transport have been the focus of recent studies in North America, Andean South America, and western Europe, but the studies vary in focus and often do not integrate information on all three components. By drawing together specialists on each component, workshop participants were able to clarify the distinct and complementary roles the three elements play in vapor transport outside the tropics.

The group reached consensus on definitions of each component. Specifically, the WCB refers to the zone of dynamically uplifted heat and vapor transport close to a midlatitude cyclone. The vapor is often transported to the WCB by an AR, and the result of the uplift is heavy rainout that generally marks the downwind end of AR conditions if the AR hasn't experienced orographic uplift (upslope flow) and rainout over mountains earlier along its approach to the WCB.

TMEs are zones of intense vapor transport out of the tropics, vapor that is frequently conducted by ARs toward cyclones and WCBs. TMEs can provide important vapor sources for ARs, but most ARs also incorporate midlatitude sources and convergences of vapor along their paths.

Participants discussed how ARs can be the pathways that connect TMEs to WCBs or orographically induced rainouts (Figure 1). However, ARs, TMEs, and WCBs also can form separately and without direct connections to each other. This taxonomy will emerge more fully in peer-reviewed literature as participants pursue collaborations initiated at the workshop.

Plans were made for special sessions A33I and A53F at the 2015 AGU Fall Meeting and for the first International Atmospheric Rivers Conference, to be held in summer 2016 at Scripps Institution of Oceanography (see http://bit.ly/IARCmtg). The conference will be open to scientists from around the world with the aim of continuing collaboration on the breakthroughs that are rapidly emerging in this field.

The workshop was sponsored by the U.S. Geological Survey and the Center for Western Weather and Water Extremes at the Scripps Institution of Oceanography.

Scientists' understanding of atmospheric rivers has grown explosively in recent years.

By **Michael Dettinger,** U.S. Geological Survey National Research Program, Carson City, Nev.; email: mddettin@usgs.gov; and **F. Martin Ralph** and **David Lavers,** Center for Western Weather and Water Extremes, Scripps Institution of Oceanography, La Jolla, Calif.

Breaking Internal Tides Keep the Ocean in Balance

By Robert Pinkel, Matthew Alford, Andrew J. Lucas, Shaun Johnston, Jennifer MacKinnon, Amy Waterhouse, Nicole Jones, Sam Kelly, Jody Klymak, Jonathan Nash, Luc Rainville, Zhongxiang Zhao, Harper Simmons, and Peter Strutton

NASA

By studying how underwater waves strike the continental slope off Tasmania, researchers seek to uncover the mechanisms that keep the circulation of the global ocean in balance.

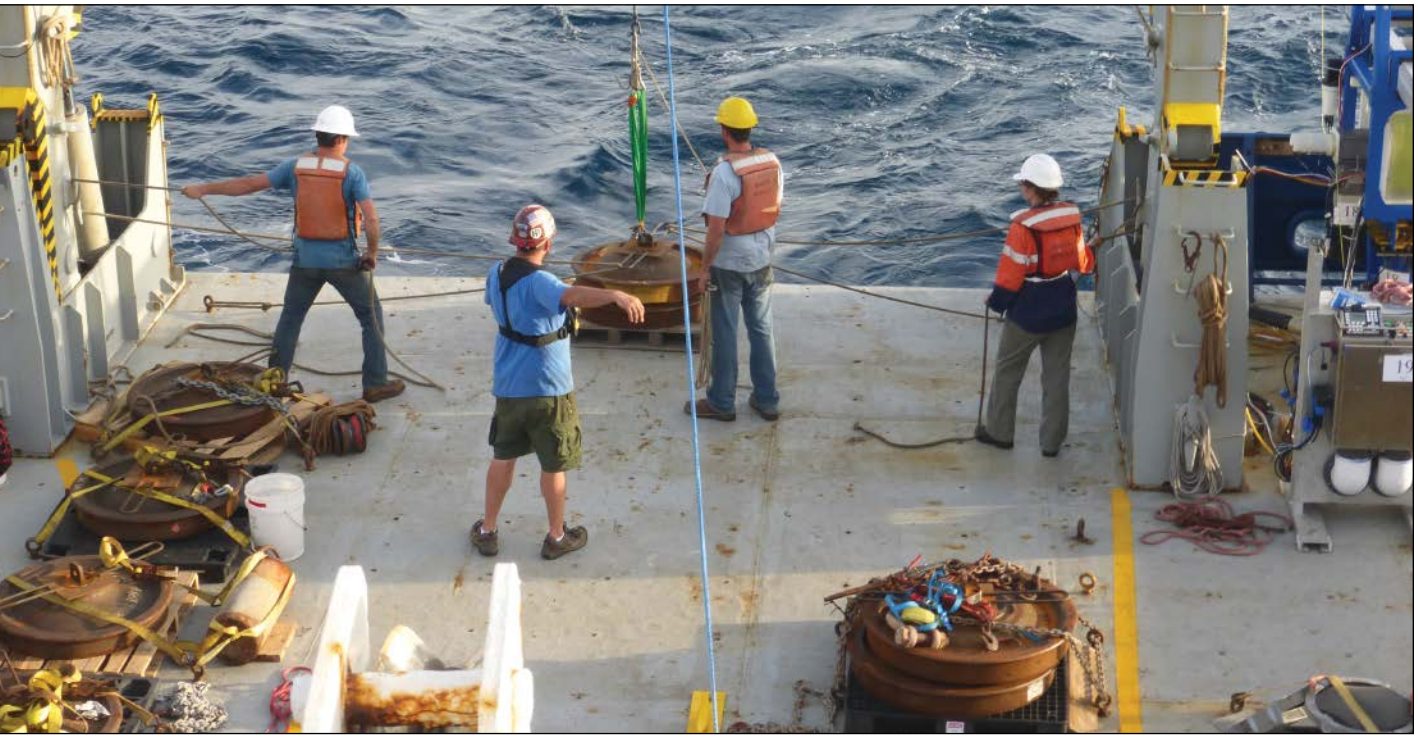
The surface waters of the ocean are heated by the Sun at low latitudes and cooled near the poles. These large-scale patterns of heating and cooling, along with the freezing of sea ice at high latitudes, set up spatial differences in density, driving the so-called thermohaline circulation of the ocean. A major feature of this circulation is the sinking of cold, dense waters at high latitudes. Along the slopes of the Antarctic continent, roughly 25 million cubic meters of water per second are plummeting downward toward the seafloor and then spreading outward, eventually covering the bottom of the entire global ocean and instigating a complex series of related currents that have a major effect on our climate.

The interacting arcs of internal ocean waves are visible near a light-blue sediment plume in this photo taken from the International Space Station.

A host of mysteries surrounds the details of this process. For example, why doesn't the ocean simply fill up with this cold Antarctic water? It should take only 1000 years or so, a mere instant on climate timescales, given the rate that water is currently sinking [*Munk,* 1966]. Scientists now think that turbulence, driven by the breaking of underwater "internal waves," mixes the heat from warmer surface waters downward and warms the rising waters that originate near the poles. To maintain the oceans in a steady state, where the downward turbulent diffusion of heat balances the upward rise of cold water, roughly 2.6 terawatts (2.6×10^{12} watts) of energy are required [*Munk and Wunsch,* 1998], roughly equivalent to humanity's total power consumption.

Turbulence Below

Finding where and how this power is delivered to the deep sea, observing the processes by which undersea waves break, and quantifying the resultant turbulent



Robert Pinkel

With a string of instruments trailing behind the ship, R/V Roger Revelle *deck boss Josh Manger (foreground) instructs the winch operator to lift an anchor made from railroad wheels off the deck. Engineer Jonathan Ladner (left) and T-Shelf principal investigators Drew Lucas and Nicole Jones (right) prepare to steady the weight as it goes overboard, dragging the instruments to the sea floor.*

mixing has proven to be a major scientific challenge. It's now thought that the tides can supply as much as a third of the needed energy. As surface tides flow across deep-sea topography, they can generate the large propagating internal waves that might significantly mix the ocean when they break.

These internal waves are first cousins to the sea surface waves we're familiar with. If you take a bucket of water and disturb the surface, gravity will try to restore it back to a flat sheet. This correction "overshoots," and the disturbance propagates off as surface waves. If the air in the top of the bucket is replaced with a layer of water only slightly less dense than the water below, the same principles apply, except the resulting internal waves move in slow motion. The waves generated as the surface tides flow over undersea topography oscillate once every 12 hours, with heights comparable to the Washington Monument and wavelengths the size of Connecticut.

When the waves eventually cross the ocean basin and come ashore, do they break similar to shoaling surface waves? Is there enough resulting turbulence in the deep sea to affect the balance of the thermohaline circulation?

Why doesn't the ocean simply fill up with cold Antarctic water?

Picking a Site

To better understand how deep mixing works in the ocean, a team of U.S., Australian, and Canadian scientists sought to study in detail what happens when internal tides hit a continental slope. We sought a clearly defined "beam" of incoming tidal energy that collides with a topographic "target" possessing an interesting range of slopes. (Steeper slopes are expected to reflect the incoming wave, whereas gentle slopes enable the wave to continue to propagate into shallower water. Intermediate, so-called critical slopes lead to wave breaking and deep turbulence.)

This situation exists in the Tasman Sea (Figure 1). An internal tidal wave with a power density of 4 kilowatts per meter is generated on the Macquarie Ridge south of New Zealand. It travels 1400 kilometers northwest over the course of 4 days and strikes the eastern slopes of Tasmania. What happens next is what we hoped to find out.

We spent the beginning of 2015 in the Southern Ocean deploying sensors and other equipment for the U.S. National Science Foundation's (NSF) Tasman Tidal Dissipation Experiment (T-TIDE; see http://bit.ly/). Our primary goal is to figure out what exactly happens when underwater tidal waves impact the eastern continental slopes of Tasmania. With this fundamental information, we then hope to determine the influence of tidal mixing on ocean circulation globally.

T-TIDE is guided by a number of recent scientific results, including historic data obtained through the Australian

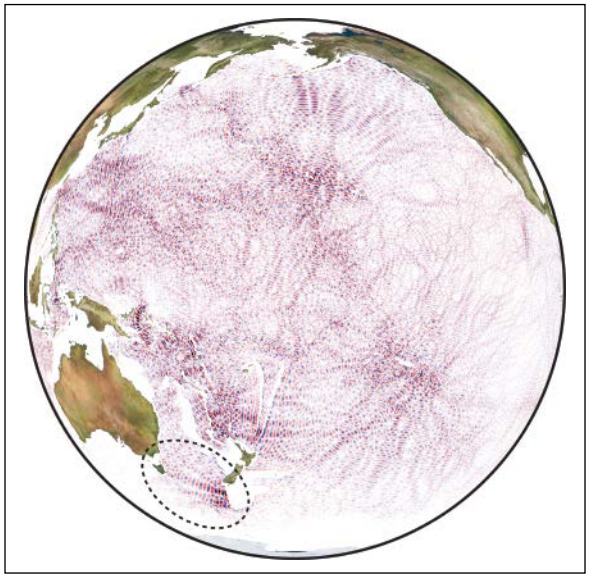


Fig. 1. Global numerical models of underwater tidal wave generation suggest that distinct tidal beams (pathways of tidal energy) cross the global ocean. Scientists have identified many of these, including the trans-Tasman beam (inside dotted circle), in satellite altimetry data. Here tidal crests (red) and troughs (blue) are shown as a snapshot in time.

Integrated Marine Observing System (see www.imos.org .au), global numerical simulations of the internal tide, satellite measurements of the ocean surface showing transoceanic internal tidal propagation, and measurements of the shoaling deep-sea tide on continental slopes in Virginia, Oregon, and China, where wave reflection as well as dissipation accounts for a significant fraction of the incoming energy.

A Raft of Measurements

In January 2015, T-TIDE scientists launched two undersea gliders and installed 15 deep-sea moorings to initiate the principal field phase of the experiment (Figure 2). The gliders carried instruments that measure electrical conductivity, temperature, and depth (CTD). Together, these sensors provide a picture of fluctuations in seawater density associated with the passing internal tides. From R/V *Roger Revelle* we deployed two arrays of moorings on the Tasmanian slope: a northern array at a site of suspected high wave energy dissipation and a southern array, where the earlier glider observations suggested that waves reflect strongly off the continental slope. The mooring arrays consisted of high-resolution thermistor chains (Figure 3a) and battery-powered vertical profilers carrying CTDs and ocean current meters. We deployed a third, triangular reflection array offshore to determine the fraction of incident tidal energy that is reflected northeastward back into the Tasman Sea.

Additional measurements were obtained from the *Revelle* in February and March to further explore the northern and southern sites and to investigate other potential mixing hot spots. These included turbulence measurements, rapid CTD profiling to resolve the internal waves and determine where they broke (Figure 3b), and concurrent density and ocean current profiles from a lowered acoustic Doppler current profiler (LADCP).

The Pulse of the Oceans

To our delight and relief, as the initial real-time data began to flow into the *Revelle*'s lab, we saw evidence of giant internal tides breaking 1000–2500 meters down in the sea. Areas of intense turbulence extending 100–200 meters above the sloping seafloor are seen on every tidal cycle. The deep sea, once thought stagnant and quiescent, is, in fact, rather explosive at special sites where the internal tide shoals. Intense turbulent events pulse with a tidal heartbeat.

As the tide breaks, a variety of nonlinear phenomena such as lee waves and bores are found, depending in part on the details of the local topography. These smaller-scale features orchestrate the specific patterns of mixing on the Tasman Slope. As we further explore the T-TIDE data, we'll attempt to uncover the principles governing this complex energy cascade. With this information, we can extend our findings off Tasmania to other sites worldwide to gain a global appreciation of how the tides help to mix the deep sea.

Broadening the Experimental Attack

Extending the T-TIDE focus beyond the continental slope, the complementary NSF program T-Beam obtained synoptic measurements (taken simultaneously over a large region) of the incident tidal beam in the central Tasman Sea. T-Beam's offshore mooring, coupled with extensive LADCP profiling from R/V *Falkor,* quantified the geometry and energy flux of the beam and documented the rate that internal wave energy attenuates in the open ocean, establishing the initial conditions for T-TIDE. The T-Beam investigators isolated the internal tide from the energetic mesoscale (10- to 100-kilometer low-frequency eddies) in the Tasman Sea and confirmed the approximate 4 kilowatt/meter trans-Tasman tidal energy flux.

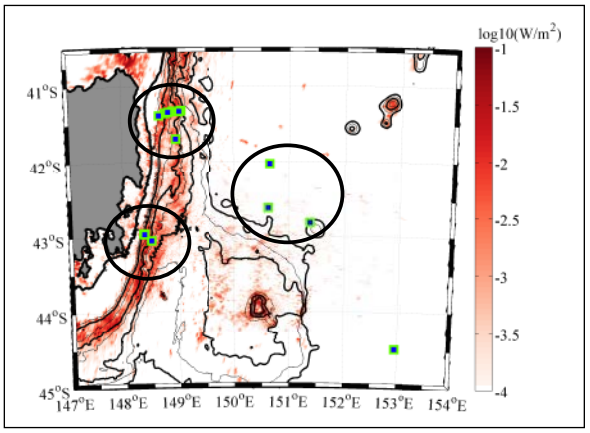


Fig. 2. Regional simulations of the shoaling and reflection of the trans-Tasman beam suggest that small-scale topographic features on the continental slope dissipate the waves' energy (color scale). Tasman Tidal Dissipation Experiment (T-TIDE) and T-Beam moorings are indicated by colored squares. The northern, southern, and reflection arrays are circled.

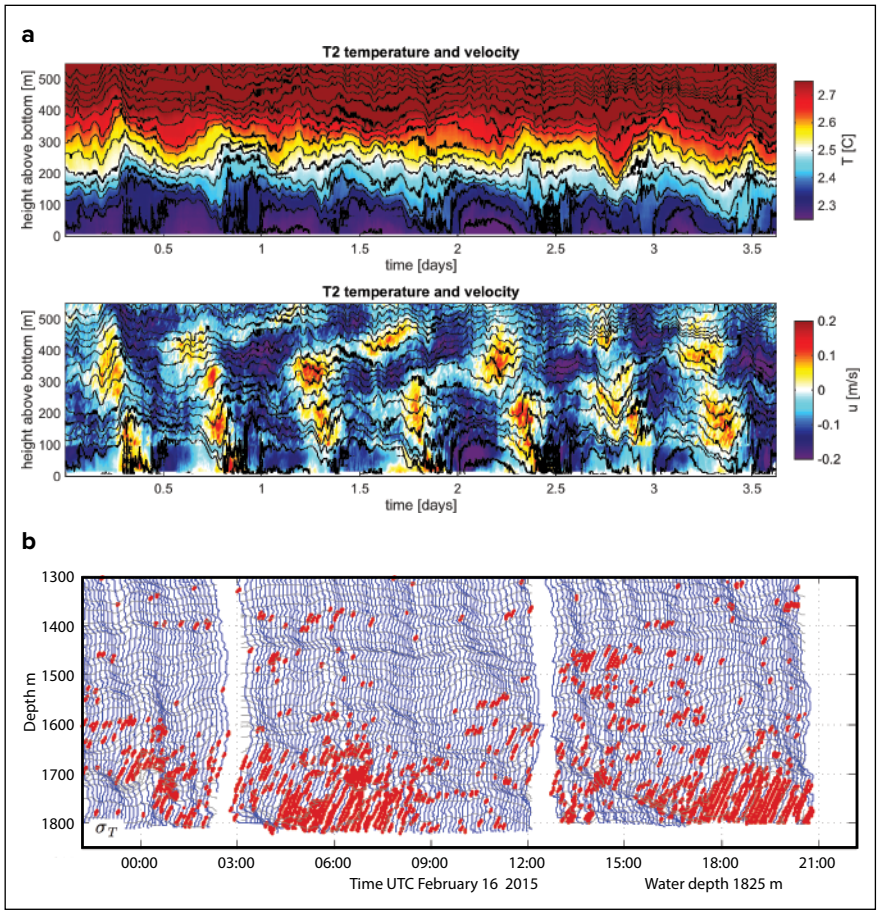


Fig. 3. (a) Representative (top) temperature and (bottom) zonal current data from a thermistor chain mooring and colocated acoustic Doppler current profiler at a depth of 2000 meters in the northern mooring array. (b) Fast conductivity-temperature-depth profiles of density (with large-scale trend removed) showing the vertical motion of constant-density surfaces with time at a depth of 1850 meters in the northern array. Red dots indicate regions of water overturning. UTC = coordinated universal time.

Concurrent with T-TIDE and T-Beam, researchers with the Australian-U.S. program T-Shelf explored the effects of the deep shoaling internal tide in shallow waters on the Tasmanian continental shelf. The purpose of T-Shelf is to relate the strongly nonlinear phenomena that establish cross-shelf and vertical sediment transport to the interplay of remote and local forces. We deployed two bottom landers, four instrumented moorings, and two Wirewalker wave-powered vertically profiling moorings inshore of the northern array in February, sampling a 15-kilometer section of the outer shelf.

We will use T-Shelf's shelf break lander data to calculate how much sediment travels across the continental shelf carried by nonlinear internal bores (where the leading edge of the internal wave steepens to become nearly vertical, much like a tidal bore) impinging on the shelf. We believe such resuspension events play an important role in sediment dynamics in coastal waters.

Profiler-mounted microstructure sensors provided continuous, full-water column turbulence observations at two locations on the shelf. We will use these data to establish how the primary energy sources on the shelf, which include the remotely and locally generated internal tides, coastal currents, and local winds, drive turbulent fluxes.

Next Steps

We successfully recovered all moorings by early March, in spite of often-rough seas and energetic mesoscale currents in the region. We are now analyzing the data to determine the fraction of incoming energy that is reflected, document the energetic mesoscale in the region, and quantify the role that evanescent, topographically trapped currents, perhaps indirectly forced by the tides, play in modulating ocean circulation.

As analysis proceeds, the combined T-TIDE/T-Beam/T-Shelf experiments will provide a comprehensive view of how deep-sea internal tides propagate and dissipate and how the thermohaline balance in the deep ocean is maintained. This will help scientists better understand ocean circulation and improve the climate models that policy makers rely on.

Acknowledgments

T-TIDE and T-Beam were funded by NSF. Participation of the R/V *Falkor* in T-Beam was provided by the Schmidt Ocean Institute. T-Shelf was supported by grants from the Australian Research Council and The University of Western Australia.

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Author Information

Robert Pinkel, Matthew Alford, Andrew J. Lucas, Shaun Johnston, Jennifer MacKinnon, and **Amy Waterhouse,** Scripps Institution of Oceanography, San Diego, Calif.; email: rpinkel@ucsd.edu; **Nicole Jones,** University of Western Australia, Perth, Australia; **Sam Kelly,** University of Minnesota, Duluth, Duluth; **Jody Klymak,** University of Victoria, Victoria, British Columbia, Canada; **Jonathan Nash,** Oregon State University, Corvallis; **Luc Rainville** and **Zhongxiang Zhao,** University of Washington, Seattle; **Harper Simmons,** University of Alaska Fairbanks; and **Peter Strutton,** University of Tasmania, Hobart, Australia

Next-Generation Scientists Get a Taste of Their Future Careers

By Patrick Edwards, Linda George, and Matthew McTammany

High school and middle school students mingled with scientists from all over the world when they presented their posters at the Joint Aquatic Sciences Meeting.

More than 200 students from 10 regional schools joined professional scientists from all over the world to present posters on their research projects at the Joint Aquatic Sciences Meeting on 22 May 2014 at the Oregon Convention Center Exhibit Hall in Portland. During the poster session, students discussed their research and visited posters presented by scientists from a wide range of aquatic disciplines.

Most professional science organizations seek ways to engage students and enhance science education at the kindergarten through 12th grade (K–12) levels [*Bestelmeyer et al.*, 2015; *Asher and Saltzman*, 2012]. Unfortunately, because the primary outreach and interaction mechanism of scientific societies is through conferences geared toward scientists at the graduate level and above, professional societies have limited resources to support interactions between their members and K–12 teachers and students.

Science fairs are a time-honored way for educators to engage students in science research and foster relationships between the school and scientific communities [*McComas*, 2011]. Recently, more emphasis has been placed on including students from traditionally underrepresented groups in science fairs [*Bencze and Bowen*, 2009; *González-Espada*, 2007]. These events are the equivalent of professional science conferences, with an emphasis on students' intellectual development.

Taking this one step further, professional science conferences present an opportunity to connect students with scientists from a range of disciplines and backgrounds. For example, AGU's Bright Students Training as Research Scientists (Bright STaRS) program provides a dedicated forum for students to share their research with professional scientists attending AGU's Fall Meeting [*Asher and Saltzman*, 2012].

Professional science conferences present an opportunity to connect students with scientists from a range of disciplines and backgrounds.

From Science Fairs to Scientific Conferences

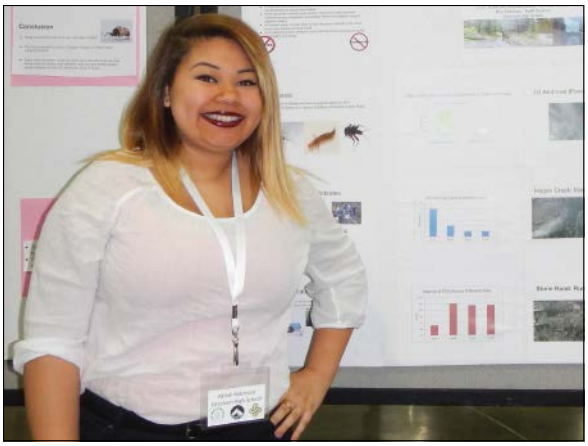
We organized a noncompetitive middle and high school poster session to take place during the 2014 Joint Aquatic Sciences Meeting (JASM) in Portland, Oreg., as a practical and meaningful way for scientists to connect with students, particularly those who are underrepresented in the sciences.

Students in the Cascades-to-Coast GK–12 program put pins in a map to mark the locations of their study sites.

Patrick Edwards

The chance to attend a professional meeting motivated students to participate in the research process and prepare their posters, and the poster session provided a relatively easy way for professionals to interact with students. To maximize student participation, JASM partnered with the Cascades-to-Coast GK–12 project in the Department of Environmental Science and Management at Portland State University, which places science doctoral students (fellows) in regional K–12 schools to improve their communication skills.

"For me, [the conference] was the turning point in my decision as a student to take my studies further. I met scientists from New York, Australia, India, and more," said Akilah Robinson (pictured to the right), a college freshman who presented a poster as a high school senior. "I also met local scientists. But out of everyone I met, there was one thing in common. They all had a passion and they all loved what they did. They all dedicated themselves to the contribution of new studies for science, and it was absolutely amazing to witness."



Cascades-to-Coast GK–12 student Akilah Robinson (Gresham High School, now graduated) stands in front of her poster on insects that live in streams, entitled "How Does Nitrate Affect Macroinvertebrate Communities," at the 2014 Joint Aquatic Science Conference.

Enthusiastic Response

Feedback from participating teachers was also very positive: "My students were thrilled to be part of the conference and were surprised at how much they knew about their subject," said Laurie McDowell, a science teacher at Lent Middle School in Portland, Oreg. Linda Wolf, a biology teacher at Glencoe High in Hillsboro, Oreg., said her students "couldn't believe they could have so much fun at a science conference."

GK–12 fellows were equally excited to be part of the JASM student poster session. "One of the highlights of the day was when I got to show my poster to my students," said doctoral candidate Nicole Alfafara, a GK–12 fellow and JASM presenter. "After viewing other professional posters at the conference, my students gave me advice on improving my own poster."

We solicited feedback from the JASM attendees about their experience interacting with students. Of the 35 online survey responses, 100% of the respondents enjoyed the experience and agreed that professional societies, such as the Society for Freshwater Science (SFS) or AGU, should continue to engage precollege students in combined poster sessions.

Twenty-six survey respondents provided written comments about the GK–12 poster session, and their feedback was strongly supportive. The majority of the comments indicated positive experiences with the students and high esteem for the quality of the students' work. For example, one survey respondent wrote, "The students were well prepared, articulate and excited. I thoroughly enjoyed talking to them about the projects." Another attendee wrote, "SFS should sponsor similar projects that coincide with the annual meeting. This type of educational outreach is excellent and hopefully will educate and convince students to pursue a career in the aquatic sciences."

"This type of educational outreach is excellent and hopefully will educate and convince students to pursue a career in the aquatic sciences."

One critique of the GK–12 poster session indicated in the survey was that JASM scientists may have been unaware of the session because of the lack of advertisement. This was due in part to the limited space in the agenda to describe the poster session, as well as the large number of sessions that were concurrent with the poster session. One respondent wrote, "To increase the attendance of conference-goers to this event in the future, it will be helpful to advertise it early and widely."

Lessons Learned

The Portland JASM conference provided a great opportunity to test out this unique poster session and collaboration. The conference was held well into the school year, so students were ready to present. The participating societies offered planning support and financial commitment, and the conference planning service provided scheduling flexibility for the session. For those seeking to organize a similar session, we can offer a few suggestions.

First, and most important, is to engage with the professional organization early; planning for large science conferences is typically a 2- to 3-year process. Another key element is to engage with universities in the conference city. Local universities are very likely to have programs aimed at K–12 inquiry and will be able to contact teachers and help organize the session. This would be especially advantageous for societies that have a conference in the same city every year.

It's important to work closely with conference planners to accommodate students and allow them to participate

without having to officially register. This may include, for example, providing custom ID badges, using a special session for the poster presentations, and working closely with the conference venue to provide logistical support and other accommodations.

Finally, it's important to ensure maximum participation by professional scientists. Advertise widely at the event or during the keynote address, and hold the session during long breaks when no other presentations are scheduled.

Currently, we are working on connecting more high schools to the SFS conference and plan to have more poster sessions in the future. At Portland State, the Department of Environmental Science and Management is inviting regional high school students to present at the annual graduate student colloquium; six high school seniors presented two posters at the graduate student poster session in 2015.

Acknowledgments

We would like to thank the JASM Executive Committee and the Society for Freshwater Science Education and Diversity Committee for providing funding and support for the poster session. The Cascades-to-Coast GK–12 program is supported by the U.S. National Science Foundation (grant 0948041). Additional funding for the poster session was provided by the Institute of Sustainable Solutions at Portland State University.

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Author Information

Patrick Edwards and **Linda George,** Environmental Sciences and Management, Portland State University, Portland, Oreg.; email: patrick.edwards@pdx.edu; and **Matthew McTammany,** Department of Biology, Bucknell University, Lewisburg, Pa.

Medalists Honored at 2015 AGU Fall Meeting

Wilfried Brutsaert Receives 2015 William Bowie Medal

Wilfried Brutsaert was awarded the 2015 William Bowie Medal at the AGU Fall Meeting Honors Ceremony, held on 16 December 2015 in San Francisco, Calif. The medal is for "outstanding contributions to fundamental geophysics and for unselfish cooperation in research."

Wilfried Brutsaert

Citation

Besides his outstanding personal contributions in research, Dr. Brutsaert has made a lasting imprint through the unselfish cooperation he embodies in all his activities. First, this is brought out by the professional success of his former graduate students, who have benefited from his generous and devoted collaborative mentorship in research. Second, since the early 1980s, Dr. Brutsaert has been a worldwide leader in bringing together the hydrologic and atmospheric research communities in the planning, design, and operation of large-scale international field experiments. Finally, Dr. Brutsaert has shown exemplary service commitment to his colleagues. Most notably, he has been directly involved in leadership in several organizations, including AGU, the American Meteorological Society (AMS), and the National Academy of Engineering (NAE).

Some highlights of his research contributions can be found in the following areas: (1) Physics of evaporation: Dr. Brutsaert was the first to successfully incorporate the effect of molecular diffusivity in the description of evaporation and heat transfer in the environment. (2) Land-atmosphere interactions: He has largely unraveled the issue of scaling in evaporation, from local scales to various macroscales. (3) Surface runoff: Dr. Brutsaert was the first to provide a realistic description of base flow using groundwater theory rather than by regression or curve fitting. (4) Porous materials: He extended Biot's theory of poroelasticity to materials containing two fluids, as found in petroleum engineering. (5) Climate change: Dr. Brutsaert is one of the few who have clarified hydrological aspects of global climate change. His 1998 paper in *Nature* resolved the "evaporation paradox" with evidence of a worldwide accelerating water vapor cycle. Later, he initiated a radically new method to deduce climatic trends from long-term river flow records.

In addition to his articles are his two landmark scholarly books, both international best sellers: *Evaporation into the Atmosphere* (Springer, 1982) and *Hydrology* (Cambridge University Press, 2004).

Among the many awards he has received, he was elected to the NAE, AGU awarded him the Hydrologic Sciences Award and the Horton Medal, and the AMS awarded him the Jule G. Charney Award and elected him an Honorary Member, its highest award. The Japan Society of Hydrology and Water Resources awarded him its International Award and made him an Honorary Member. The Japan Society for the Promotion of Science gave him the Award for Eminent Scientists.

In conclusion, it is difficult to imagine a colleague more deserving of the Bowie Medal.

—Jean-Yves Parlange, *Cornell University, Ithaca, N.Y.*

Response

President Leinen, ladies and gentlemen, friends. Looking back I have to wonder how it all finally came to this because this outcome really was never in the cards. My early years were certainly not a prologue for a scientific career, what with the vagaries of the world war and the spartan conditions and severe financial limitations with which our parents had to raise my five siblings and me. My high school education was mainly directed to the study of classical Latin and Greek as an ideal preparation for a career in law, literature, and philosophy, with only perfunctory coverage of mathematics and physical science.

In spite of this meager science background, but with some youthful idealism, I decided on becoming involved with problems in the developing world. This led me to a major in water engineering at the University of Ghent to acquire the practical skills needed for my admittedly vague objectives. Surprisingly, and contrary to my earlier misgivings, calculus, which I had never been exposed to before, and physics became my favorite subjects. A second turnaround came during an internship with an antierosion organization in Africa, where we had to determine the irrigation requirements for natural grassland; when the chief engineer asked me to read a seminal paper by Penman on evaporation, I came to realize that fundamental science is not only essential for even the most pedestrian of our field problems but also intrinsically beautiful all by itself. Later, Don Kirkham and his theoretical soil physics work inspired me to pursue graduate studies in the subject, and through him I enrolled at the University of California at Davis. There in 1959 the final turning point occurred, when Don Nielsen insisted that I join AGU. The meetings and publications of AGU guided me in the choice of most of the topics I took up since then; moreover, the atmosphere of both scholarship and comradeship in AGU has broadly shaped the remainder of my professional life.

In closing, considering everything I owe AGU, I'm really having some difficulty finding the proper words here to express my profound gratitude for this ultimate recognition. So I will simply say thank you and in the same breath also include Jean-Yves Parlange, Kuo-Nan Liou, and the letter writers for the nomination, as well as the members of the Bowie Medal Committee for their confidence. And although she doesn't want me to, I gratefully acknowledge the support of my wife, Toyo, my best friend for the past half century.

Finally, nobody lives in a vacuum, and we are all shaped by our environment. Therefore, this award fills me also with great satisfaction because it reflects rightfully on the many colleagues and students with whom I had the privilege to work over the years.

—Wilfried Brutsaert, *Cornell University, Ithaca, N.Y.*

Cassak, Ehlmann, Heald, Jackson, and Maher Receive 2015 James B. Macelwane Medals

Paul Cassak, Bethany List Ehlmann, Colette L. Heald, Matt Jackson, and Kate Maher were awarded the 2015 James B. Macelwane Medal at the AGU Fall Meeting Honors Ceremony, held on 16 December 2015 in San Francisco, Calif. The medal is for "significant contributions to the geophysical sciences by an outstanding early career scientist."

Paul Cassak

Citation for Paul Cassak

Paul Cassak has made groundbreaking contributions to our understanding of magnetic reconnection, which operates in the boundary regions of planetary magnetospheres and the solar corona as well as having great significance in laboratory plasma physics and plasma astrophysics. Good examples of Paul's groundbreaking research are his work on asymmetric reconnection and reconnection with a flow shear. Early models of reconnection, where magnetic fields effectively break and release their stored energy, treated symmetric systems for simplicity. However, most realistic systems, especially planetary magnetospheres, have different magnetic fields, densities, and/or bulk flow speeds across the boundary region. Just as simulation studies on the topic were beginning in earnest, Paul performed a first-principles calculation predicting the properties of reconnection in asymmetric systems for generic conditions and has since included the effects of plasma flow. These results have facilitated the analysis of satellite data and may be important for predicting solar wind–magnetosphere coupling, a key aspect of space weather phenomena.

In the solar context, his work on the initiation of reconnection through which built-up magnetic energy is released explosively has been influential. It was generally assumed

that reconnection, when it happens, is always fast (matching solar flare and magnetospheric substorm time scales), but if it's always fast, how can it be explosive? Paul's research answered this question, which had lingered for decades. In a series of papers, Paul showed that when a current sheet separating opposing magnetic fields forms and has large width, resistive effects dominate, and the fields reconnect relatively slowly. When the sheet thins to kinetic scales, collisionless effects abruptly become dominant, and reconnection becomes much faster. Paul's research showed that there exists a vast parameter regime in which both types of reconnection are stable. He developed several innovative tests of this hypothesis and successfully validated it; the results may be crucial for understanding solar flares.

These and other unique new results in Paul's impressive body of work have helped revitalize the field of magnetic reconnection and have significantly changed its course.

As an associate professor at West Virginia University, Paul is an active mentor in the fields of space and plasma physics, publishing important papers with his students. As a teacher, he developed novel active-learning materials for graduate courses in plasma physics. His service activities for AGU include chairing the Scarf Award Committee, being an associate editor for *Journal of Geophysical Research,* and serving on the Space Physics and Aeronomy Policy Committee.

—James L. Burch, *Southwest Research Institute, San Antonio, Texas*

Response

Thank you, Jim, for the kind citation. I guess all those years of not being popular in high school really paid off! My sincere thanks to the Macelwane Medal Committee, my nominators, and AGU for their efforts for the community.

An honor like this is truly humbling and makes me reflect on the people who contributed to my career, especially four people I've never even written papers with. Jim Burch is the principal investigator of the Magnetospheric Multiscale (MMS) mission, which successfully launched in March 2015. In his "spare" time, he was the lead on my nomination. As long as our community has science-driven and civic-minded people like Jim, we'll be in good shape. Joe Borovsky shared my work with many people, Jim Klimchuk opened doors for me, and Kile Baker believed in me. All of you give the community something to aspire to.

Words cannot express my gratitude to my mentors, especially my doctoral and postdoctoral advisers Jim Drake (Maryland) and Mike Shay (Delaware). I met you accidentally in 2002 and feel extremely lucky to be able to call you mentors, colleagues, and friends.

I have learned much from my colleagues in solar and space physics; an incomplete list includes Dr. Dorelli, Dr. Eriksson, Dr. Fuselier, Dr. Glocer, Dr. Gosling, Dr. Matthaeus, Dr. Mullan, Dr. Murphy, Dr. Phan, Dr. Servidio, Dr. Swisdak, and Dr. Wilder.

I am grateful to my supportive colleagues at West Virginia University, especially Earl Scime. I am forever indebted to you for your guidance and support.

I have been fortunate to have a supportive family throughout my life. My mother, Kit, my father, Barry, and my brother, Todd, have been there for me through thick and thin.

To my love, Julie Bryan, I'll never know how I got such a great wife. You are funny and serious, patient and encouraging, thoughtful, sweet, smart, and, most of all, supportive. Did I mention smart? And funny? It's been a pleasure and privilege to go through time with you. Thank you for making me a better person.

Finally, James Macelwane treasured his students. I too have collaborated with outstanding students (Dr. Malakit, Dr. Parashar, Dr. Shepherd, Dr. Komar, Dr. Beidler, and the future Dr. Haggerty, Dr. Doss, and Dr. French), who have enriched my scientific pursuits immeasurably. To all the students reading this—know that you can make important contributions to science and be successful with a lot of hard work and a little luck. Remember that devoting a career to the pursuit of knowledge is an honor.

—Paul Cassak, *West Virginia University, Morgantown*

Bethany List Ehlmann

Citation for Bethany List Ehlmann

Bethany Ehlmann has made exceptional contributions to the identification and understanding of the alteration mineralogy of Mars, linking surface composition to its geologic context and the implications for the planet's habitable past. She has made major new mineralogical discoveries on Mars, including carbonates, clay minerals, and other aqueous alteration phases. She has demonstrated that geologic associations of these minerals suggest their production through hydrothermal and groundwater processes occurring in the shallow or middle crust. This is among the most important unanticipated discoveries of the last decade of Mars exploration, as it reveals the nature of the crustal reservoir of mineral-bound water and associated alteration phases and points us toward new terrestrial analog models of the Mars water cycle.

While her dissertation and postdoctoral work has emphasized orbital spectral data analyses from the Compact Reconnaissance Imaging Spectrometer for Mars (CRISM) and the Observatoire pour la Minéralogie, l'Eau, les Glaces et l'Activité (OMEGA), Bethany's contributions to Mars rover missions began when she was an undergraduate at Washington University. She served in many indispensable mission operations roles on the Mars Exploration Rovers, Spirit and Opportunity, and honed her already formidable scientific skills by contributing to team publications in *Science* and *Nature*. Her rover involvement continues to this day with mission-critical leadership roles on the Mars Science Laboratory (MSL) rover Curiosity, including the fact that the results of her orbital data analysis influenced the landing site selection for MSL.

As evidence of Bethany's far-ranging intellectual interests, she began in an undergraduate program for students with interests in scientific, political, cultural, and ethical issues associated with the environment. She was selected as a Rhodes Scholar, completing two master's degrees in environmental change and management and geography at the University of Oxford before her Ph.D. in geological sciences at Brown University. Following her Ph.D., she completed a Marie Curie Fellowship at Université Paris-Sud in Orsay. Her extensive publication list (more than 65 peer-reviewed papers) includes topics in astrobiology, polar processes, terrestrial analogs, and advanced instrumentation for future landed missions.

In a field that attracts highly capable scientists, Bethany is clearly a standout, with the technical sophistication, intellectual rigor, and leadership abilities to be at the vanguard of the scientific and technical challenges that await the future of Mars and planetary exploration.

—Wendy Calvin, *University of Nevada, Reno*

Response

It was a surprise and honor to receive this award. Many thanks to my nominator, Wendy Calvin, whom I've had the privilege of working with and learning from on two mission teams.

About 15 years ago—it does not seem so long ago—I attended my first fall AGU meeting as an undergrad. Surfing between remote sensing, biogeochemisty, mineralogy, geomorphology, and planetary sciences, I remember thinking "This is where the fun science is at."

It remains both fun and a privilege to be part of this community today. Mars science has been an exciting scientific ride, fueled in no small part by the superb data generated by two dedicated Mars imaging spectrometer teams, OMEGA and CRISM, led by Jean-Pierre Bibring and Scott Murchie, along with numerous other amazing friends and colleagues on the Mars Exploration Rover (MER), Mars Reconnaissance Orbiter (MRO), and MSL missions. One of the lessons I've learned is that doing great science takes technical skills, commitment, and intuition but also surrounding yourself with a supportive community of mentors. Special thanks go to Ray Arvidson at Washington University for setting me off on this path of exploration as an undergrad, as well as to my mentors on the MER mission—I wouldn't have found my way to planetary science without you. My thanks also go to John Boardman and Heather Viles at Oxford for honing my skills as an independent researcher and to Jack Mustard, my awesomely supportive Ph.D. adviser at Brown, who encouraged me to dive deeply into the data. Thanks also go to the cohort at Institut d'Astrophysique Spatiale–Orsay for support during my second foray over the Atlantic and to many supportive faculty, postdoc, graduate student, and staff colleagues at the California Institute of Technology and Jet Propulsion Laboratory. Special thanks go to John Grotzinger, Ray, and Scott for writing letters in support of this citation.

Looking to the future, it is an exciting time to be in planetary science. Having at least flown by all the major bodies in the solar system, we now have to test our understanding of how planets work and evolve against data from the telescopic discoveries of exoplanets. MSL is climbing a mountain on Mars, we're preparing to examine and sample the most primitive asteroids, and we're gearing up to explore icy worlds with subsurface oceans. Armed with ever-expanding tools for doing science in situ, there is a revolution in understanding each time we send robotic landers and rovers to unexplored locales. I'm looking forward to the next decades of discoveries. Thank you.

—Bethany List Ehlmann, *California Institute of Technology, Pasadena*

Colette L. Heald

Citation for Colette L. Heald

Colette Heald is a greatly respected and influential young leader in atmospheric chemistry. Her work has broken new ground in a number of areas, including the use of satellite data to quantify emissions and track intercontinental transport of pollution; methods for investigating aerosol aging processes; and insights into the factors controlling the abundances of organic aerosols, dust, and primary biological particles.

One of Colette's great strengths is her ability to effectively interact with experimentalists, synthesizing observations and modeling into new provocative concepts. In one of her most cited papers, she used aircraft data and modeling to demonstrate the woeful inadequacy of current understanding of organic aerosol sources in the remote atmosphere. This paper triggered a decade of research to improve models and observations. Colette's own subsequent excellent work on the topic established her as an authority on secondary organic aerosols. She documented in particular the unique interactions between natural and anthropogenic emissions in the formation of organic aerosol, and she applied her knowledge of satellite remote sensing to place new constraints on the global budget of organic aerosol, dramatically reducing the previous range of uncertainty.

Colette has a talent for innovative thinking that leads to new ways of approaching problems. An outstanding example is her proposal of the van Krevelen diagram to quantitatively track the evolution of the composition of organic aerosol during its aging in the atmosphere. The van Krevelen diagram has its origin in the petrochemical processing field. Colette's idea to apply it to field data to track the progress of atmospheric oxidation was simply brilliant!

Colette distinguishes herself also by her service to the research community. She has chaired the Aerosols Working Group of the GEOS-Chem atmospheric model for many years, leading a group of over 50 aerosol scientists worldwide in identifying and implementing priorities in model development. She has convened five AGU Fall Meeting sessions.

Colette's vision for the importance of aerosols in the Earth system, combined with her strong grounding in aerosol chemistry and physics, puts her in a powerful position to lead the development of new understanding on the connected roles of aerosols in affecting climate, air quality, and biogeochemical cycles.

—Sonia Kreidenweis, *Colorado State University, Fort Collins*

Response

My deepest thanks to my colleagues for supporting this nomination and AGU for the tremendous honor. In particular, I'd like to thank Sonia Kreidenweis for her kind nomination and her support as a colleague and mentor.

The Macelwane Medal represents the highest honor of my career. It is especially humbling to receive this as a recognition of contributions to geosciences. Atmospheric chemistry is a fairly young discipline in the geosciences; it brings together scientists with a range of backgrounds to study what I consider to be the science behind the Earth's most pressing environmental issues. This makes for a magical combination of multidisciplinary problem solving within a friendly and collaborative community. I count myself lucky to be a part of it. And I am grateful for AGU's recognition of our field.

It has been my privilege to work with inspiring people within outstanding institutions. My Ph.D. adviser Daniel Jacob taught me how to put together a compelling scientific argument; he also taught me that boring talks and papers are the scourge of academia! Harvard showed me how motivating it is to be surrounded by smart people. As a postdoc at Berkeley, I learned to appreciate the diversity of scientific perspectives and approaches. Allen Goldstein taught me how to believe in my own scientific vision, and I've benefited tremendously from his generosity ever since. I can't say enough about the support and encouragement I received from my colleagues at the Department of Atmospheric Science at Colorado State University; they truly helped launch my faculty career. Finally, it's a privilege and inspiration to be at the Massachusetts Institute of Technology (MIT). I'd like to thank my colleagues in the Department of Civil and Environmental Engineering and the Department of Earth, Atmospheric and Planetary Sciences for their support. Living up to this institution is a daily challenge!

I would also like to thank all of the women in science who have made it possible for me to receive this award and whose own accomplishments are far too rarely recognized. I hope that AGU continues to support and honor the work of women in the geosciences. For myself, I cannot overstate the importance of having a support network of women colleagues whose advice, commiseration, and "gold stars" are invaluable to me: Arlene Fiore, Allison Steiner, Julie Fry, Delphine Farmer, Annmarie Carlton, and Jen Murphy.

Finally, I'd like to thank my research group, past and present, for making it such a wonderful experience to come to the office and work with you every day.

—Colette L. Heald, *Massachusetts Institute of Technology, Cambridge*

Matt Jackson

Citation for Matt Jackson

Matt Jackson reinvigorated the type of mantle geochemistry studies pioneered by his Ph.D. adviser Stan Hart through a combination of analytical advances and a focus on global-scale issues as revealed by extraordinarily fine details of the chemistry of ocean island volcanic rocks.

For his Ph.D., Matt perfected in situ analyses of the strontium isotopic composition of melt inclusions protected within early-crystallizing minerals in oceanic basalts. His results showed beyond doubt that the mantle source of Samoan lavas contains a component of recycled continental crust carried by the deep mantle plume that feeds Samoan hot spot volcanism. Matt, with student Rita Cabral, provided definitive evidence for the presence of recycled sediment in the mantle through their discovery of mass independently fractionated sulfur isotopic composition in basalts from the island of Mangaia. These data confirm a role for recycled sediment but also show that the sediment involved was at Earth's surface over 2.4 billion years ago. Placing time constraints on the transit time of subducted material through the mantle has been an elusive goal for decades. Matt, working with colleague Rajdeep Dasgupta, showed that mantle compositional variation as reflected in basalt composition is not just expressed in a few obscure trace elements but instead reflects general major element compositional variation in the mantle. As such, the compositional variability has consequences for mantle dynamics because of the contribution of composition to rheology, density, and radiogenic heat production. Matt's discoveries thus provide a major step forward in the information needed to better understand the forces driving the dynamics of Earth's interior.

Another of his contributions is a series of papers that attempt to define the characteristics of the hypothetical primitive mantle. Matt first suggested that the high helium-3 mantle source, which most associate with primitive undegassed mantle, has some chemical and isotope characteristics inconsistent with traditional models that invoke chondritic relative abundances of the refractory lithophile elements in the bulk Earth. Matt then matched his model for the "not-so-primitive" primitive mantle to the compositional characteristics of major flood basalt provinces to suggest that the largest volcanic events on Earth sample a mantle reservoir created by differentiation events that accompanied Earth formation.

Matt's work has dramatically impacted our understanding of the composition of Earth's interior, the processes accompanying Earth formation that drove initial differentiation, and the longer-term consequences of continent formation and crustal recycling through plate tectonics in creating the Earth we know today.

—Richard Carlson, *Carnegie Institution for Science, Washington, D. C.*

Response

Thank you, Rick, for your generous citation. And thanks to the cadre of supporters who contributed to my nomination. This really provides an opportunity to thank some of the people who have inspired me over the years.

In my high school days in Montana, Dave Mogk gave me the opportunity to pack his rocks around in the Beartooth Mountains, and I was hooked on geology. Thus primed, I took an introductory geology course from Jeff Park during my freshman year in college. I loved it. Interactions with other folks at Yale—Jay Ague, Karl Turekian, and Brian Skinner—convinced me that I had chosen the right major. Phil Ihinger introduced me to research, and I will forever be thankful for his enthusiasm and the time he invested in shaping my thinking about hot spot volcanoes.

The Woods Hole Oceanographic Institution–Massachusetts Institute of Technology Joint Program was a terrific place to explore hot spot volcanism, so I signed up for 5 years with Stan Hart. I couldn't have chosen a better adviser and mentor, and he set a wonderful example for how one should mentor students. Nobu Shimizu and Mark Kurz were unofficial thesis advisers and geochemical coconspirators: many ideas were born during conversations in their labs.

A postdoc at Carnegie can only be described as "geochemical paradise." Rick Carlson was supportive of exploring a lot of neat ideas, and I am lucky to have his mentorship. Rick, Steve Shirey, and Erik Hauri opened up Pandora's box—

unlimited geochemical resources and facilities—and I will always be grateful.

Al Hofmann has been omnipresent in my short career: He's a gentleman and keeps me on the straight and narrow. Janne Blichert-Toft, Jurek Blusztajn, and Josh Curtice were generous with time and resources when I had no lab, and I am forever indebted.

My graduate and undergraduate students—my academic family—have inspired me to be a better teacher and mentor. In particular, I thank Rita Cabral, Ellie Price, and Drew Reinhard. Your ideas and hard work are the reason I am here today.

My grandfather, a bricklayer and a cowboy, taught me the value of a hard day's work. I owe a lot to the example he set for me and to the support that I received from my parents, brother, and sister. This medal should really be presented to my wife, Anna, who is infinitely patient and has been my closest friend and my strongest supporter. Thank you, Anna.

—Matt Jackson, *University of California, Santa Barbara*

Kate Maher

Citation for Kate Maher

Kate Maher has made extraordinary contributions to our understanding of the geochemistry of critical zone processes. Her achievements have impacted our understanding of silicate weathering, soil formation, groundwater flow and transport, and the global carbon dioxide cycle.

Kate's research specifically focuses on the rates of chemical reactions that occur at Earth's surface and down to shallow depths. She has used her expertise in isotope geochemistry and reactive transport modeling to understand how water moves through rock materials, transforming it chemically. Her insightful analysis of how to interpret the disequilibrium of uranium isotopes is informing the interpretation of erosion and soil production.

Her impactful work began during her graduate work at Berkeley and has developed into a more generalized use of isotope systematics in hydrologic systems during her tenure at Stanford. She and her students are now bridging the divide between hydrological and geochemical modeling to push forward the understanding of flow and transport in soils, aquifers, and deeper reservoirs. Geochemical measurements hold the promise of constraining hydrologic modeling at a variety of spatial and temporal scales, and Kate's work is pushing forward this frontier both from a theoretical point of view and in application to real systems.

Her models and data have elucidated several long-standing puzzles. She clarified one of the main reasons why the kinetics of reactions are observed to be slower in the laboratory than the field. She presented quantitative models explaining paradoxes related to solutes and stream flow in catchments. Her latest work is elucidating the thermostat for the global carbon cycle. At the same time, she is contributing to more applied problems related to the geological sequestration of carbon dioxide and radionuclides in the environment.

Kate has the quantitative skills, geological insights, and leadership talent needed to tackle the biggest problems in Earth surface processes. We currently know more about modeling the movements of air masses and ocean waters globally than we know about modeling the movements of water, solutes, and particles in the highly heterogeneous critical zone. Kate will be at the forefront as we evolve in our understanding of this frontier.

—Susan L. Brantley, *Pennsylvania State University, University Park*

Response

Thank you, Sue, for your generous citation and for your support and encouragement over the years. You have been a role model for so many young scientists, and on behalf of all of us, I thank you for the myriad roles that you have played in our careers.

It is a tremendous honor to receive the James B. Macelwane medal, and I thank AGU, the nominations committee, and my nominators for creating this special moment that I will cherish for the remainder of my career.

I have had the good fortune to stand on the shoulders of several giants in my field. First, I would like to acknowledge my Ph.D. adviser, Don DePaolo of the University of California, Berkeley, whose infinite understanding of Earth processes and unique ability to envision even the most complex as simple "chemical reactors" have always challenged me to evaluate the most simple case first as it is often where the central challenges become apparent. I would also like to thank Carl Steefel at Lawrence Berkeley National Laboratory for his ceaseless patience in converting an engineer into a geochemical modeler and for leading me into the field of reactive transport. I would also like to thank the U.S. Geological Survey Mendenhall program and Jennifer Harden, Art White, and David Miller for introducing me to the fascinating world of soils.

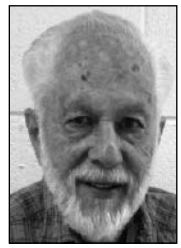
At Stanford University, I encountered another cast of giants who have offered new shoulders and new views. I chose Professor Gordon Brown as my faculty mentor, hoping he would be honest and fair in providing feedback. This turned out to be quite an underestimate. Gordon not only introduced me to the beautiful world of surface chemistry but provided boundless advice, as well a few prescient nudges. I could not imagine a better mentor. Dennis Bird, Page Chamberlain, and Scott Fendorf at Stanford have also been outstanding mentors and teachers, as have the many postdocs, students, and staff who have crossed paths with our research group. The latter are too numerous to name; however, I am sincerely grateful to all of them for their intelligence, spirited natures, and hard work.

Finally, I wish to thank my family for their patience, encouragement, and support. My mother, Celia Kathleen (CK), has always been my anchor, and without her I could not have become a geoscientist. My husband, Matthew, is a true giant upon whose shoulders I stand every day.

—Katharine Maher, *Stanford University, Stanford, Calif.*

Andrew F. Nagy Receives 2015 John Adam Fleming Medal

Andrew F. Nagy was awarded the 2015 John Adam Fleming Medal at the AGU Fall Meeting Honors Ceremony, held on 16 December 2015 in San Francisco, Calif. The medal is for "original research and technical leadership in geomagnetism, atmospheric electricity, aeronomy, space physics, and related sciences."



Andrew F. Nagy

Citation

Professor Andrew F. Nagy is a most appropriate selectee as the 2015 John Adam Fleming Medalist for his seminal contributions to the understanding of the chemistry, dynamics, and energetics of the terrestrial and planetary ionospheres. He began his career in the 1950s on sounding rockets and followed the ascent of the space program to ever-greater altitudes in our atmosphere and then to even greater distances from the Earth to the atmospheres of Venus, Mars, Jupiter, and Saturn.

His contributions have been as both an experimentalist and a theoretician. He has had an enormous influence on the fields of solar-terrestrial physics and planetary atmospheres. He has applied his knowledge of the Earth's atmosphere to better understand the physical and chemical processes of the planets of our solar system. One of his key contributions to planetary science was guiding the Pioneer Venus aeronomy and solar wind interaction investigators as they struggled to understand this first and best example of the interaction of a flowing magnetized plasma with a neutral atmosphere and its ionosphere.

He has contributed importantly to science policy and to the transference of scientific knowledge to the community through his recent book, his publications, and his lectures. Not only has he had a remarkable career of his own, but he has influenced a large number of successful scientists in their research, training the next generation of atmospheric and space scientists to follow their own paths of excellence.

—Christopher Russell, *University of California, Los Angeles*

Response

Chris, thank you very much for your very kind words. Also many thanks to colleagues who supported my nomination and the committee who made the selection. Looking at the list of previous awardees makes me especially humble to join their company. Being honored by the American Geophysical Union is also very meaningful to me as I saw it grow over the last 50 years. The first *Journal of Geophysical Research* on my shelf is from 1961, and I remember the first West Coast Meeting at Stanford University around 1963.

At this time it is very appropriate to acknowledge all the people who helped me along my career and were along for the very rewarding and exciting ride that brought me to this point. I was an electrical engineering undergraduate in Sydney, Australia, and as the result of a fluke encounter I received a Fulbright Grant to do graduate work in the United States. Another fluke sent me to Michigan, where looking for a summer job, I was sent to see Nelson Spencer, who at that time was the director of the Space Physics Research Labora-

tory (SPRL). He offered me a summer job, which was the beginning of a long and very rewarding career in space science. George Carignan, who was the director of SPRL from 1963 to 1984, was a very supportive and important person in my career. I started out doing experimental work, and the many engineers and technicians, too many to list, played a very important role in these efforts. I moved into theoretical and modeling activities in the 1970s, and from then on I owe a tremendous amount of credit to my colleagues, students, and postdocs. In the latter category are Rich Stolarski, Ralph Cicerone, Bill Chameides, Tom Cravens, and Tamas Gombosi; the last two became colleagues with whom I have worked closely to date. I also need to acknowledge some of the many other colleagues whom I worked with over all these years, such as Peter Banks, Ian Axford, Rick Chappell, and Bob Schunk. Of the many wonderful students let me just mention four, namely, Ray Roble, Janet Kozyra, Hunter Waite, and Yingjuan Ma. Over the years I was also fortunate to be part of numerous spacecraft missions, including OGO-6, Dynamics Explorer, Pioneer Venus, Phobos, and Cassini, which opened exciting new horizons for me.

Last, but not least, I want to thank my family for their support and understanding in putting up with all my absences.

—Andrew F. Nagy, *University of Michigan, Ann Arbor*

Russ E. Davis Receives 2015 Maurice Ewing Medal

Russ E. Davis was awarded the 2015 Maurice Ewing Medal at the AGU Fall Meeting Honors Ceremony, held on 16 December 2015 in San Francisco, Calif. The medal is for "significant contributions to the ocean sciences."

Russ E. Davis

Citation

Davis's contributions to oceanography are distinguished by unique breadth and a profound impact. Davis began his career by elucidating the role of nonlinearity and dispersion in forming solitary internal waves and by explaining how surf on a beach excites edge waves. He has made fundamental contributions to understanding Lagrangian velocity statistics and ocean property transport. He has focused the most critical of intellects on understanding the limits of ocean observations and climate predictability. Davis introduced objective mapping to the oceanographic community, and now oceanographers cannot analyze data without heavy reliance on this technique.

Davis has been unwilling to be confined by existing instrumentation and has made transformative contributions to ocean-observing technology. He led development of the first acoustic Doppler current profilers for ships and self-contained units for moorings. With Bob Weller, Davis designed the vector measuring current meter. But Davis's greatest single contribution to ocean technology is the development, with Doug Webb, of the autonomous Lagrangian circulation explorer (ALACE). These ALACE floats evolved to become the basic platform of the Argo ocean-observing system. Argo routinely reports currents and makes high-quality temperature and salinity measurements to 2000-m depth across the ice-free ocean. Many oceanographers contributed to the success of Argo. But Davis designed a key component, and his leadership was crucial at the creation.

Comparing Russ Davis with Maurice Ewing is irresistible. First and foremost, both combine a rigorous theoretical intellect with a determination to make observations of the ocean. Argo is Russ's answer to Ewing's imperative to collect as much ocean data as possible, everywhere and all the time. Ewing was a forceful and outspoken personality. Bullard in his biography of Ewing says, "He never asked anyone to do what he would not have done himself, and in fact he could and would do almost anything." Those of you who know Russ personally will see the similarities. But doing almost anything is not wise: Ewing was swept overboard and almost lost his life at sea. Russ has developed robotic observers that relieve oceanographers from the dangers and discomfort of seagoing work. Finally, what might have happened if Russ Davis had followed Maurice Ewing and become the director of his home institution? It would have been amusing to observe events in La Jolla from the distant safety of Woods Hole or Hawaii.

The 2015 Ewing Medal recognizes Davis's pioneering contributions to the solution of many important problems in oceanography and his monumental work in the design of ocean observing technology.

—William Young, *University of California, San Diego, La Jolla*

Response

I thank Bill Young for his citation putting a splendid spin on my career—beware Australians telling tales. Thanks also to the people who make awards possible by nominating colleagues or donating time on awards committees making Solomon's choices.

The American Geophysical Union's awards recognize the accomplishments of individuals. It is fitting to do this and delightful to be recognized. But, I believe, most accomplishments are the product of a community generously helping the young and freely sharing ideas. This is not a new perspective, but let me tell why it is mine.

I inherited my father's joy in model airplanes, amateur radio, and such, which led me toward engineering. In engineering graduate school, a bulletin board flyer sent me to the Woods Hole Oceanographic Institution summer program, where Stewart Turner offered to mentor me when my intended adviser disappeared. After a couple months seeing how Turner used laboratory observations and simple models to learn fascinating things, I had unbounded enthusiasm and a thesis topic. Imagine the magnanimity of my chemical engineering adviser, Andreas Acrivos, giving his time and funds to help me study internal waves in his lab! With characteristic grace and generosity, this highly recognized engineer opened the door to oceanography.

Scripps was dominated by giants. Walter Munk and John Miles at the Institute of Geophysics and Planetary Physics invited me into a world looked at through mathematical glasses; "down the hill," Chip Cox and Fred Spiess had amazing ways to observe and discover things in the ocean. All helped repair my educational holes and made oceanography awfully fun. It was Chip who suggested that the then new acoustic ship's log might become an affordable miniaturization of the giant acoustic Doppler current profiler that Fred Spiess and Rob Pinkel had built on the floating instrument platform (FLIP)—shipboard and self-contained Dopplers followed. Chip's lab was a hotbed of technology, including a vertically cycling probe that freed microstructure measurements from ship motion. When Joe Reid showed me fascinating tracks from John Swallow's floats, the World Ocean Circulation Experiment (WOCE) float was borne; Terry Joyce suggested adding a conductivity-temperature-depth profiler. Had it not been for Dean Roemmich, that float would have been just another observing specialty. But Dean had the revolutionary vision to turn it into a global observing system, Argo. While he was doing that, I helped Jeff Sherman design the Spray glider; we have been using it ever since.

So I gratefully accept the Ewing Medal with deep gratitude to all those who helped me do useful things and have tremendous fun.

—Russ E. Davis, *Scripps Institution of Oceanography, La Jolla, Calif.*

Günter Blöschl Receives 2015 Robert E. Horton Medal

Günter Blöschl was awarded the 2015 Robert E. Horton Medal at the AGU Fall Meeting Honors Ceremony, held on 16 December 2015 in San Francisco, Calif. The medal is for "outstanding contributions to hydrology."

Günter Blöschl

Citation

Günter Blöschl has been not only a phenomenal researcher, educator, and synthesist but also a visionary leader in catchment hydrology.

Günter's research has spearheaded a whole-system view that envisions observable spatial hydrologic patterns as manifestations of internal dynamics. Günter's early work on snow patterns unraveled how patterns of snow albedo, melt, and redistribution are controlled by topography. He devised novel methods to infer the organization of water flow paths from measured soil moisture patterns. He systematically analyzed spatial flood processes to discover regional patterns of rain on snow and flash floods, each having a distinct spatial scaling behavior. He introduced new frameworks for diagnosing flood regime changes across Europe using regional process indicators, permitting attribution of anthropogenic effects. Within the field of sociohydrology he cofounded, he brought out emergent long-term dynamics

resulting from two-way feedbacks between humans and floods.

Günter is a true visionary and an innovative thinker, and the many concepts he has introduced have made a huge impact. His scale concepts are used widely across several fields, beyond hydrology. The patterns approach he pioneered has been influential in the way hydrologists look at patterns and processes through the prism of scale. Günter is a synthesizer. Through a synthesis across processes, places, and scales (as part of Predictions in Ungauged Basins) he linked the process representations of low flows, floods, and runoff hydrographs through the concept of water balance, helping to unify the entire field of catchment hydrology.

Günter's quest for bridging theory and practice has resulted in the adoption of his concept of "flood frequency hydrology," which enriches statistical approaches with process understanding, by the official flood estimation guidelines in several European countries. The ensemble flood warning system he developed is now used operationally in the Danube River. In these ways, Günter has made a huge impact on both the scientific community and society as a whole. There is no greater evidence of his stature as a geoscientist than his service as president of the European Geosciences Union and his recent election as president of the International Association of Hydrological Sciences.

Günter Blöschl's innovations grounded in observations, deduction, and theory bear remarkable similarity to the thinking espoused by Robert Horton himself. His visionary and unselfish contributions to the advancement of the field therefore make him a most worthy recipient of the Horton Medal.

—Upmanu Lall, *Columbia University, New York, N.Y.*

Response

I am delighted to receive this medal and humbled to join the roll of past recipients, including such luminaries as Walter Langbein, Charles Theis, and Mikhail Budyko. I thank Manu Lall for leading the nomination and for his generous citation.

Manu highlighted my work linking patterns to processes. I have always been fascinated by patterns of flowing water and how they come about. One of my favorite pastimes as a child was to sit and watch the flow of water and, where there was an opportunity, to build little dams in mountain creeks or at the beach to divert the water and shape its flow. This may well be the reason why, later in my career, the deductive approach to learning from patterns struck a chord with me. Quoting Sherlock Holmes, "The case is one where we have been compelled to reason backward from effects to causes." Perhaps we in hydrology too should give greater emphasis to deductions, as opposed to the usual practice of calibrating preconceived models to data, to parallel Sherlock Holmes's proverbial successes.

Manu also wrote about my passion for bridging theory and practice. I've been fortunate to have had Dieter Gutknecht as a mentor who introduced me to hydrology at the crossroads of science and engineering, which soon became second nature to me. Over the years, there have been numerous unexpected synergies, hardly planned but a confluence of circumstances, such as when flood design issues inspired novel estimation methods or when regional process interpretations helped improve practice. The recent 50th anniversary special issue of *Water Resources Research* again provided an opportunity to reflect on the perennial problem of theory versus practice. As global water pressures mount, interaction between human and water systems is enjoying a great revival, with renewed focus on feedbacks and coevolutionary processes. This is an exciting prospect that, I hope, will lead to a happy synthesis of two theses often mistakenly considered antitheses.

While I take pride in receiving the Horton Medal, I share it with Rodger Grayson, Andrew Western, Ralf Merz, Duro Parajka, Robert Kirnbauer, Alberto Viglione, Bruno Merz, Jan Szolgay, Siva Sivapalan, Hubert Savenije, Alberto Montanari, and many other colleagues, as well as generations of my students, who have greatly shaped my intellectual development. My final words of thanks go to my wife, Elisabeth, and our wonderful children, Roman, Agnes, and Margit, for their love and support over many years.

—Günter Blöschl, *Vienna University of Technology, Vienna, Austria*

Claude Jaupart Receives 2015 Harry H. Hess Medal

Claude Jaupart was awarded the 2015 Harry H. Hess Medal at the AGU Fall Meeting Honors Ceremony, held on 16 December 2015 in San Francisco, Calif. The medal is for "outstanding achievements in research on the constitution and evolution of the Earth and other planets."

Claude Jaupart

Citation

Claude Jaupart has made major contributions to several areas of solid Earth science. His contributions include understanding the physics of volcanic eruptions, igneous processes in magma chambers and intrusions, geodynamics, in particular related to mantle convection and the role of continents, and heat flow in the Earth. His work ranges from geophysical fluid dynamics to behavior of elastic materials to heat transport problems.

Claude's contributions to volcanology and magma physics have been exceptional. His research includes elucidating how stress fields control dike emplacement; insights into crystallization of magmas, magma convection, conduit flows, degassing dynamics of magma chambers and eruptions, formation of layered intrusions, development of overpressures in magma chambers, formation of magma chambers, evolution of lava lakes, and the rheological behavior of bubbly magmas; and understanding of magma fragmentation. A seminal contribution concerns the thermal and dynamical behavior of the Earth including heat flow measurements on continents, radioactivity within the continental crust and lithosphere, interpretation of heat flow measurements on continents and oceans, convection in the mantle, and viscous melts and lava flows. Claude has had a career-long commitment to measuring the heat flow through the Canadian cratons. His discovery of low mantle heat flux is one of the most important pieces of observational work on the continents.

Claude's research is characterized by a highly rigorous quantitative approach to science. He sees understanding observations and data as the key rationale for modeling, experimentation, and analysis. All of his research places observations and data at the forefront, even in his more theoretical endeavors. Claude adopts a holistic approach combining elegant laboratory experiments, astute development of theoretical models, and a deep knowledge and respect for observations. His primary motivation is to understand the natural world through his deep knowledge of the underlying physics. He is technically outstanding, applying rigorous mathematics to his modeling and analysis of data. He has tremendous creative ability to think of the right clever experiment or insightful development of a model and a flair for identifying the right questions and key issues.

Claude is widely known for being kind, courteous, generous with his time, and insightful of colleagues. He has nurtured several outstanding graduate students, many of whom are independently making significant contributions. He has provided leadership of French geoscience and is Institut de Physique du Globe de Paris director for the second term. Claude Jaupart is an outstanding recipient of the Hess Medal because of the breadth, depth, and quality of his scientific contributions.

—Stephen Sparks, *University of Bristol, Bristol, United Kingdom*

Response

The American Geophysical Union, the Hess Medal, and Steve Sparks are all so prestigious that I have been inflated to the bursting point. This medal carries special significance because of Harry Hess's considerable achievements and breadth of research. I have spent countless hours poring over his landmark papers on seafloor spreading and on the Stillwater complex. His studies typify what is so exciting about our science, the intimate connections between the compositions of minerals and rocks, geological activity, and the deep churning of our planet. It is a great privilege to be associated with him.

My scientific development has been due to the energetic push and inspiration from a few remarkable scientists. It all began when I joined John Sclater's group at the Massachusetts Institute of Technology, where the level of scholarship and enthusiasm was intoxicating. John kept his group on a permanent high with his constant support for new ideas and emphasis on the large-scale picture. I moved back to France at Claude Allègre's urging to develop research on the physics of magmatic and volcanic processes at Institut de Physique du Globe de Paris. Claude provided far-field scientific vision and fought hard for what was then a burgeoning field. I met Steve Sparks and Herbert Huppert at almost the same time. Their groundbreaking studies of magmatic and volcanic processes had been eye-openers and have remained a constant source of inspiration. A fantastic field trip to Santorini volcano and a wonderful stint at the University of Bristol in their company solidified my resolve. I also had the good fortune to forge a lasting part-

nership with Jean-Claude Mareschal. We embarked on a 3-decades-long heat flow program that yielded an exceptional data set and powerful constraints on the thermal structure and evolution of continents. None of these would have happened without Jean-Claude, his nimble mathematics, his steadfastness and unselfishness, not to mention his encyclopedic knowledge of jazz music that kept us alert when we were logging deep boreholes.

The natural world has so many wonders to offer in so many different guises that exciting research topics abound. Definitive answers have rarely come from a single scientific discipline, but it is clear that the development of geological fluid dynamics has had a profound impact. I have been very fortunate to see this happening and am deeply grateful to AGU and to the many friends and colleagues who made this possible.

—Claude Jaupart, *Institut de Physique du Globe de Paris and Université Paris-Diderot, Paris, France*

Anne M. Thompson Receives 2015 Roger Revelle Medal

Anne M. Thompson was awarded the 2015 Roger Revelle Medal at the AGU Fall Meeting Honors Ceremony, held on 16 December 2015 in San Francisco, Calif. The medal is for "outstanding contributions in atmospheric sciences, atmosphere-ocean coupling, atmosphere-land coupling, biogeochemical cycles, climate, or related aspects of the Earth system."

Anne M. Thompson

Citation

For Anne Mee Thompson, dedicated scientist and generous colleague, winning the Roger Revelle Medal has the air of poetry. For 4 decades, Anne has been making sustained, essential contributions to the advancement of our understanding of interactions between the composition of the troposphere and climate. She has held leadership roles in globally influential organizations such as the international Commission on Atmospheric Chemistry and Global Pollution, the International Association of Meteorology and Atmospheric Sciences, and the International Ozone Commission. Along the way, she found time to introduce countless young people to the wonders of science and urgency of protecting our fragile environment and for a stint at president of the Atmospheric Sciences section of AGU.

Early in her career, Anne held appointments at the Woods Hole Oceanographic Institution and at the Scripps Institution of Oceanography when Roger Revelle was still an inspiring presence. With mentoring from Oliver Zafiriou and Ralph Cicerone, Anne left a mark in marine atmospheric studies of the cycling of formaldehyde and reactive free radicals and later at NASA Goddard Space Flight Center showed that satellite data can be used to estimate fluxes of biogenic sulfur compound involved in climate-chemical feedbacks.

Anne has led the way on studying and shaping our understanding of the atmosphere's ability to cleanse itself, linking chemical changes to climate perturbations. She addressed satellite observations of tropospheric ozone and air quality over the ocean on several cruises, including on R/V *Akademik Korolev,* where she assembled a suite of trace gas measurements demonstrating the utility of ship-based observations for evaluation of remotely sensed data.

Anne's research on ozone in the remote troposphere involved work in locations as diverse (and sometimes inhospitable) as Arctic Canada, Mexico, Panama, Ireland, Greece, Japan, and southern Africa. Her ozonesonde networks, most notably Southern Hemisphere Additional Ozonesondes (SHADOZ), provided data for hundreds of researchers and helped the ozonesonde achieve its highest level of precision since its introduction in the 1960s. Throughout these efforts Anne has been a constant inspiration to students and postdocs at the Pennsylvania State University and the University of Maryland, as well as entraining and inspiring scientists from underrepresented groups in the developing world, including many women.

In a career that in some ways parallels that of Roger Revelle, Anne Thompson's scientific contributions and exceptional achievements in the area of Earth observations, from ground to space, especially trace gases in the tropics, make her a fitting winner of AGU's 2015 Roger Revelle Medal.

—Russell Dickerson, *University of Maryland, College Park*

Response

Thanks to you, Russ, and to the Revelle Committee for this honor. When something like the Revelle happens, one is humbled to think of the people who share in the scientific achievements the medal represents. You mentioned Ollie Zafiriou and Ralph Cicerone, who turned a photochemist into an atmospheric scientist. When it was time to leave postdoc life, Rich Stolarski and Marv Geller brought me to the Atmospheric Chemistry and Dynamics Branch at NASA Goddard. Career advice in the mid-1980s proved true: "Do good science, try new ideas; the rest will follow." It was easy to discover links between tropospheric trace gases and diverse aspects of the Earth system—ocean biology, fires, and ice cores—when colleagues were trying out-of-the-box approaches to solve the Antarctic ozone hole. Part of the satisfaction of interdisciplinary research was working with remarkable people across Goddard, at universities, and with the National Oceanic and Atmospheric Administration and U.S. Environmental Protection Agency.

Something was missing in that early work; we were running a lot of models with almost no data. A turning point came in the 1990s. On the Third Soviet-American Gas and Aerosols cruise, for example, we tested photochemical theory with new instruments in the pristine tropical Pacific atmosphere. Everything worked (!), and I was initiated into the exciting world of international experiments. Transport and Atmospheric Chemistry Near the Equator–Atlantic (TRACE-A)/Southern African Fire-Atmosphere Research Initiative (SAFARI-92) quickly followed, beginning long collaborations with African and Brazilian colleagues. Our data improved satellite algorithms and proved that lightning, not just fires, causes an ozone maximum in the tropical Atlantic. The SHADOZ ozonesonde network took off in 1998, thanks to dedicated operators who continue to turn out high-quality data, often under hard conditions.

Eight and half years as a Penn State meteorology professor (for which I thank Bill Brune) widened intellectual horizons and showed the joy of learning from bright students. In turn, I challenged them to embrace the NASA mission and public service. One Penn State graduate, Goddard's John Yorks, already has an instrument on the International Space Station.

How lucky I was to join Goddard again, in 2013, recruited by Bill Lau, Jose Rodriguez, and Jim Gleason. Besides working with amazing satellite data, I spend time filling gaps in global networks, recruiting talent, and strategizing new missions. Roger Revelle, who made Scripps a great climate center, provided the funds to start Dave Keeling's Mauna Loa carbon dioxide record. Isn't that the most important part of this medal? It reminds all of us to keep Earth observations strong in challenging times.

—Anne M. Thompson, *NASA Goddard Space Flight Center, Greenbelt, Md.*

Peter Olson Receives 2015 Inge Lehmann Medal

Peter Olson was awarded the 2015 Inge Lehmann Medal at the AGU Fall Meeting Honors Ceremony, held on 16 December 2015 in San Francisco, Calif. The medal is for "outstanding contributions to the understanding of the structure, composition, and dynamics of the Earth's mantle and core."

Peter Olson

Citation

Throughout his career Peter has inspired students and fellow geophysicists with his scientific insight and explanations and has gained international respect as a leader in studies that have improved our understanding of the structure and dynamics of the Earth's interior. Peter has made significant scientific advances related to both the mantle and core of the Earth, two very different regimes requiring very different research expertise. Peter has accomplished this via two different approaches: numerical modeling and laboratory experiments.

Peter developed some of the original models of tectonic plate motions coupled to convectively driven mantle flows and of heterogeneous chemical composition of the mantle due to subducting slabs and rising plumes. He supported these theories and model simulations with the first laboratory experiments using variable-viscosity corn syrups, which provided explanations for surface observations like "trench roll-

back" and seismic observations like subducting slab deformation and partial penetration into the lower mantle. Peter is a coauthor of the comprehensive book *Mantle Convection in the Earth and Planets* (2001), which reviews the huge advances made over many decades in our understanding of mantle dynamics.

Peter has also studied the Earth's core using numerical simulation and laboratory experiments. He motivated and led the first parametric study of hundreds of planetary dynamo simulations to learn how the structure, intensity, and time dependence of the resulting magnetic fields depend on various parameters of the model. His work led to the identification of different regions in parameter space that determine the frequency of dipole reversals based on convective versus rotational effects. In one region dominated by rotation Peter showed that magnetic dipole reversals do not occur; in another dominated by convection dynamos continuously reverse, and between these two regions the dynamo only occasionally produces dipole reversals. The geodynamo falls into this third parameter regime. Using laboratory experiments, Peter demonstrated how a rapidly rotating and strongly convecting sphere of fluid produces columnar flow patterns, which are critical for the geodynamo. He also conducted experimental studies of magnetoconvection and the growth of the Earth's inner core. By organizing and editing *Core Dynamics,* volume 8 in the *Treatise on Geophysics* (2007), Peter provided a valuable resource that describes our current understanding of the Earth's core.

—Gary A. Glatzmaier, *University of California, Santa Cruz*

Response

Thank you, Gary, for the generous citation and for working with other colleagues to advance my nomination for the Lehmann Medal. I am very aware that recognition like this stems from the efforts of many folks, and it is humbling and deeply satisfying to be selected as a contributor to our understanding of the deep Earth.

I first became an American Geophysical Union member in 1978, and it is remarkable to recall the limited state of understanding of the vast region of the lower mantle at that time. Seismic velocity models and associated geodynamical and mineralogical interpretations were not dramatically different from those available in the days of Inge Lehmann's seminal work on the inner core. The accumulation of analogue recordings by the worldwide standardized seismological network and advances in numerical methods for computing seismic waves for one-dimensional Earth models had set the stage for moving forward, but few seismologists were working on deep-mantle problems. Indeed, my own work with Don Helmberger was initially focused on quantifying upper mantle lateral variations, and when we first advanced interpretations of deep-mantle discontinuity structure, the general response by the few who cared was rather dismissive skepticism.

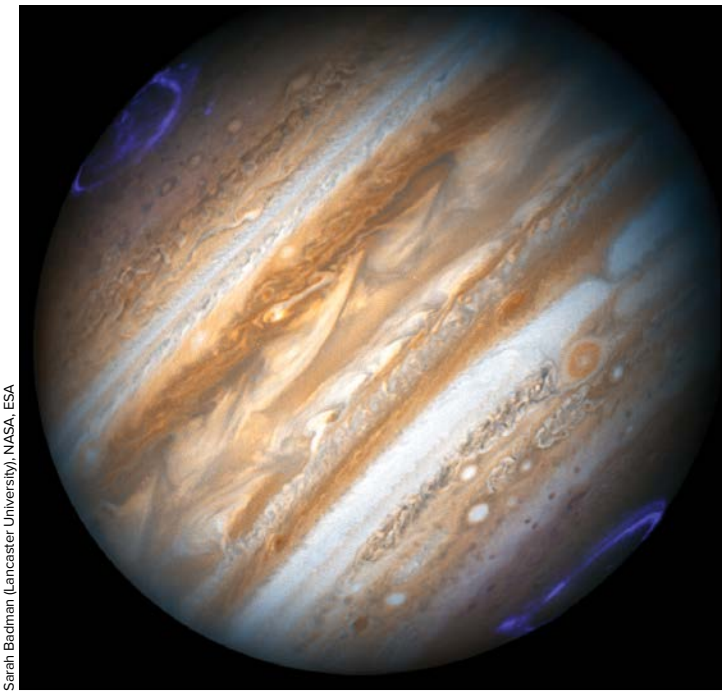
Fast-forwarding to today, progress has been dazzling, with a large and vigorous international interdisciplinary research community advancing the frontiers of our knowledge. This is reflected in a proliferation of unpronounceable acronyms like LLSVP (large low-shear velocity provinces), ULVZ (ultralow velocity zones), and pPv (postperovskite) and the integrated efforts by organizations like SEDI (Study of the Earth's Deep Interior) to understand the detailed chemistry, transport properties, and evolution of the deep mantle and core. Topics such as deep-mantle anisotropy, barely suggested in work preceding 1978, now engage joint seismological, geodynamical, and mineralogical modeling efforts that build upon state-of-the-art capabilities of different disciplinary efforts.

Our understanding of the deep mantle and core is now sophisticated, but great uncertainties and challenges remain; I am sure that the next generation of results will revise some of our current paradigms, and hopefully, it will provide new acronyms that are easier to say.

I've been very fortunate to work on seismology of the deep mantle and core with wonderful mentors, colleagues, and graduate students, along with receiving institutional support from great programs at the California Institute of Technology (Caltech), the University of Michigan, and the University of California, Santa Cruz. This recognition is shared among us all, and I deeply appreciate the many collaborations.

—Peter Olson, *Johns Hopkins University, Baltimore, Md.*

What Makes Jupiter's Aurora Pulse?



Sarah Badman (Lancaster University), NASA, ESA

Bright patches glow in Jupiter's ultraviolet aurora observed by the Hubble Space Telescope.

Earth has spectacular displays of auroras, the light shows unleashed when solar wind and plasma interact in the atmosphere. When it comes to sheer scale, however, they've got nothing on Jupiter, which is the home of the strongest planetary magnetic field in the solar system. Over the past couple of decades, scientists have used both telescopes and satellites to take stunning images of arcs of ultraviolet light shimmering around the gas giant's poles.

Unlike Earth's auroras, the Jovian auroras are nearly continuous, driven by the planet's fast rotation and its volcanic moon Io, which spews sulfur and oxygen ions and electrons out into space. These electrons race along the planet's magnetic field and, if they're powerful enough, slam into the atmosphere and cause air molecules to glow.

But Jupiter's auroras aren't static—they swell and recede, pulsing at times with bursts of light lasting hours or even days. These variations are a clue to unraveling the physics in Jupiter's magnetic field.

Tao et al. observed Jupiter's aurora with the Japanese space telescope Hisaki, measuring the variations in brightness. They saw two kinds of auroral pulses. In one, the aurora brightened for up to several days at a time. The authors think this brightening is due to the solar wind: As it washes over the planet, the charged particles buffet and compress Jupiter's magnetic field, similar to what happens on Earth.

But they also saw much faster variations, pulses lasting less than 10 hours. By comparing the Hisaki observations with images taken simultaneously by NASA's Hubble Space Telescope, the team could see that this type of pulse was due to the aurora brightening at lower latitudes, at the bottom of the auroral arc, as reported by Kimura et al., 2015, doi:10.1002/2015GL063272.

Using Hisaki's onboard spectrometer, the team was also able to estimate how fast the electrons were traveling on the basis of how deep in the atmosphere the light was originating. They found that when the aurora flares up, it's not because faster, more powerful electrons are penetrating deeper into Jupiter's atmosphere. Instead, the flaring is due to an increase in the overall number of electrons. This suggests that Jupiter's most intense auroras occur when plasma is suddenly injected into its magnetic field—most likely from Io. (*Journal of Geophysical Research: Space Physics*, doi:10.1002/2015JA021272, 2015)

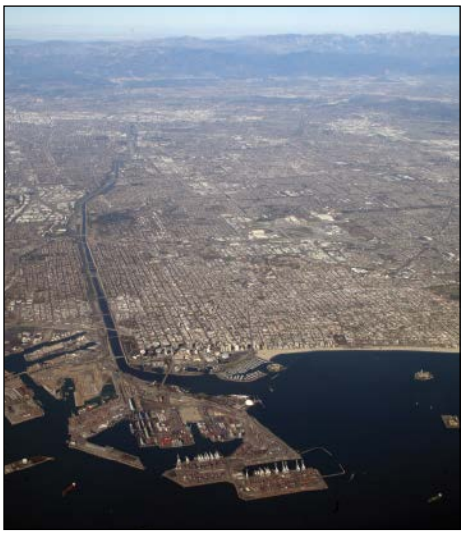
—Mark Zastrow, Freelance Writer

Extracting New Meaning from Seismological Data

Traditionally, seismic hazard studies have used data from past earthquakes to estimate the shaking from future earthquakes. These historical observations have shown that differences in the topography, density, and other properties of rocks surrounding a fault will affect the amount, nature, and duration of shaking.

Data from historical events are limited, however, and may only provide average properties of a region or city. A more detailed assessment can be obtained using an array of geophones that listen to the high-frequency noise of the Earth. *Bowden et al.* analyzed data from a dense array of more than 5200 geophones located an average of only 100 meters apart in Long Beach, Calif., across the Newport-Inglewood fault.

The authors combined ambient noise cross-correlation and wavefront tracking techniques to map the amplitudes of surface waves. The ambient noise cross-correlation technique extracts surface wave signals from background noise, and the wavefront tracking technique recovers amplification patterns from the local geology in detail. For example, the authors' maps imply that amplitudes of shaking during an earthquake may be much greater in the southwestern part of the array and suggest how the structure of the fault itself plays a role. (*Geophysical Research Letters*, doi:10.1002/2014GL 062662, 2015) **—Catherine Minnehan, Freelance Writer**



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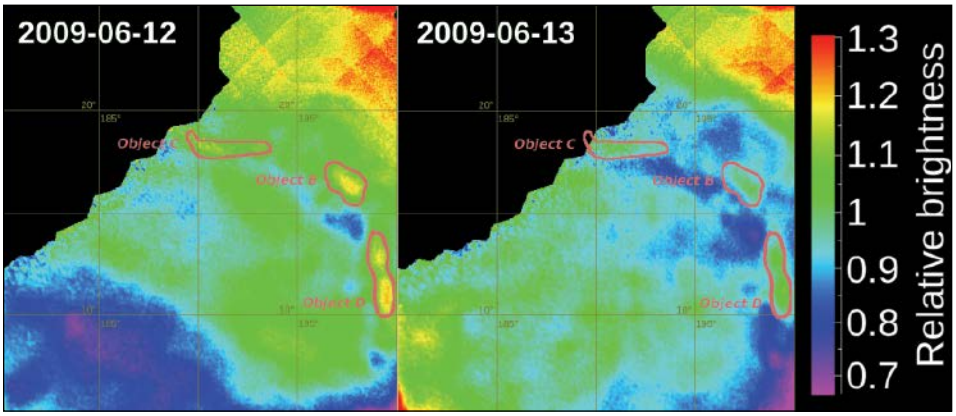
Long Beach, Calif.—location of the nodal seismic geophone array.

Evidence for Volcanoes on Venus



Adapted from *Shalygin et al.*

A camera on board the European Space Agency's Venus Express spacecraft monitored infrared light coming from the dark side of the planet's surface for evidence of ongoing volcanic activity, and it revealed four hot spots (three shown here as outlined areas).

Even though it's our closest neighbor in the solar system, many questions about the geology of Venus remain unanswered. Previous analyses have shown evidence of historic tectonic and volcanic activity, but scientists have debated whether the planet remains active today.

Shalygin et al. used a camera on board the European Space Agency's Venus Express spacecraft to monitor thermal emissions from the planet's surface and find evidence of ongoing volcanic activity. The camera was set to absorb infrared light (wavelength 1.01 micrometers) from the dark side of Venus, and the team discovered four temperature anomalies (hot spots) over the course of 316 observational sessions that produced 2463 images of the Ganis Chasma region.

By monitoring the precise location and shape of the bright spots as the spacecraft orbited, the team was able to conclude that the signal was coming from the planet's surface as opposed to its atmosphere. According to the team, volcanic activity could be creating the hot spots, which are predicted to be between 800 and 1100 kelvins (≅520°C–830°C) and range from 1 to 200 square kilometers in size.

The findings are bolstered by the fact that the observed temperature anomalies all occurred in the Ganis Chasma, an area of the planet's surface suspected to contain a range of geological activities. These activities—such as faults, mantle upwelling, and lithospheric extension (a fundamental plate tectonic process)—are the same mechanisms that lead to volcanism on Earth.

The authors suspect that the eruptions on the Venusian surface are somewhat contained by the planet's incredible surface pressure, which is 100 times greater than our own. Instead, eruptions on Venus are predicted to be slow, oozing effusions. These insights into Venus's volcanic activity contribute to ongoing research into the geodynamics of our solar system. (*Geophysical Research Letters*, doi:10.1002/2015GL064088, 2015) **—David Shultz, Freelance Writer**

Subsurface Craters Expose the Moon's Dramatic Past

The Moon wears its dramatic history on its face, in the chaotic array of craters blanketing the lunar surface. The Moon has no atmosphere to drive erosion and no modern volcanic or tectonic activity, making impact cratering the primary agent of change.

Partly because of this activity, the Moon's crust is highly porous. This porosity extends deep into the crust, between 10 and 25 kilometers, and possibly into the lunar mantle. Porosity affects many properties of the surface area, including heat conduction and liquid permeability. Studying crustal porosity—and how it develops in a terrestrial planetary body—offers scientists valuable insight into the thermal and chemical processes that drive the evolution of planets.

Soderblom et al. looked at data collected by the two Gravity Recovery and Interior Laboratory spacecraft, which measure the Moon's gravitational field. The team studied gravitational anomalies to quantify the relationship between crater size and porosity generated by impact. They found evidence that the amount of porosity created by an impact is related to the crater size for craters up to 100 kilometers in diameter. (The porosity associated with larger craters is likely truncated at depth.) The amount of pore space after impact was also determined by impact variables like size, velocity, and angle.

The researchers further suggest that in cases where the crustal porosity is very high, impacts are actually capable of reducing porosity. Thus, averaged over large areas, impact cratering leads to porosity equilibrium. In other words, after enough impacts occur in an area, the density of the Moon's surface will not change, on average, with new impacts.

The constant bombardment also results in cratering equilibrium, where craters are created and destroyed at roughly the same rate. Although the Moon's surface may be a kind of geologic Etch A Sketch®, the gravity signature of the lunar subsurface still contains an intact record of past cratering that reveals its history.

These insights contribute to a scientific understanding of planetary bodies and how they evolve. The unique physical conditions of the lunar surface offer scientists a helpful analogue for crustal conditions on a young, Archean Earth and similar developmental stages on other planets, like pre-Noachian Mars. The study of surface features and the history they reveal is fundamental to our growing knowledge of the galaxy. (*Geophysical Research Letters*, doi:10.1002/2015GL065022, 2015) **—Lily Strelich, Freelance Writer**

NASA

On the lunar surface, craters are created and destroyed at roughly the same rate. The gravity signature of the lunar subsurface, however, retains an intact record of past cratering.

The Role of Low-Altitude Clouds in a Changing Climate

The Earth's changing climate is the product of complex exchanges between the ocean and atmosphere. Scientists explore these exchanges using general circulation models (GCMs), which calculate the circulation of the ocean or atmosphere. The models account for the Earth's rotation and thermodynamic interactions, like radiation and latent heat, but scientists still struggle to pin down how clouds influence climate feedback. Here *Qu et al.* develop a methodology to identify how low-lying tropical marine cloud cover responds to temperature changes in GCMs and assess the role of clouds in a changing climate.

The scientists first identified two major variables that control cloud coverage: latent heat flux and moisture gradient. In this case, latent heat flux describes the energy released as water evaporates from the Earth's surface and collects in the troposphere. The moisture gradient represents how moisture collects in the air with respect to altitude: The boundary layer closest to the Earth's surface gets drier with increasing altitude. In this study, the team used sea surface temperature as a proxy for these two variables.

They found that the cloud feedbacks created in GCMs could be attributed to three key changes. The first is stronger tropical inversions—meteorological phenomena in which the normal stratification of the atmosphere is reversed, so that cool, moist air is trapped under warm, dry air. The stronger the inversion is, the less mixing occurs between the boundary layer and the dry upper air of the troposphere. Less mixing produces a shallower, wetter, cloudier boundary layer.

The other changes are an increase in surface latent heat flux and an increase in the difference in moisture content at different heights (due to a greater increase in moisture near the surface compared with higher altitudes). In contrast to stronger tropical inversions, these changes hinder the formation of low cloud cover.

Overall, the team found that when models accurately simulated the response of low cloud coverage to inversion strength and sea surface temperature variations, low cloud cover decreased. Without the reflective layer of clouds, the Earth's surface absorbs more solar radiation. Therefore, a decrease in low cloud coverage can drive an overall increase in warming. The authors hope further study of cloud sensitivity will help to improve cloud feedback modeling. (*Geophysical Research Letters*, doi:10.1002/2015GL065627, 2015) **—Lily Strelich, Freelance Writer**

Tony Hisgett, CC BY 2.0 (http://bit.ly/ccby2-0) (Image cropped)

Clouds over the Atlantic. Recent research found that a decrease in low cloud coverage can drive an overall increase in warming.

The Element of Surprise in Managing Flood Risk

Flooding events cost lives and cause damage to infrastructure, agriculture, and homes across the world. When floods occur in vulnerable regions lacking preparedness, the results can be disastrous.

In a new study, *Merz et al.* approach the problem by integrating a social sciences perspective with natural and engineering sciences, focusing on the element of surprise in flood risk assessment and management. The researchers identify two distinct sources of surprise: the complexity and unpredictability of the flood risk and biases in human perception and thinking. They advocate for wider evaluation of both potential sources of surprise in order to better mitigate flood risk.

Andreas Rietzschel. Used with permission.

In August 2002, the residents of Wesenstein in the Ore Mountains in Germany were taken by surprise by sudden and extreme flooding that demolished whole houses.

The team explains the role of surprise using metaphors from early cartography: terra incognita (unknown land) and terra maligna (wicked land). Early mapmakers approached uncharted territory in different ways, leaving portions of a map blank (incognita) or projecting society's fantasies and fears in the form of wildly imaginative animals and geographic features (maligna). The researchers suggest that modern flood risk decision makers face a situation similar to that of early mapmakers—working with the unknown and dealing with the consequences of unexpected developments.

The team suggests multiple approaches to reduce surprise across different aspects of flood risk management. These include broadening the kinds of evidence that scientists collect, increasing the dimensionality of risk analyses, and using risk assessment and scenario generation methods from multiple disciplines. But their recommendations also include deliberate attempts to address psychological sources of surprise.

These suggestions aim to help managers better anticipate the potential for surprise in flood scenarios by considering the factors that limit predictability, like model limitations or biases in human risk perception. Finally, the authors emphasize the importance of collaboration, uniting the expertise of hydrologists, engineers, and social scientists for a more holistic approach. The authors hope this evaluation will complement scientific advances in flood prediction, helping managers to better utilize technological tools and better protect human lives and livelihoods. (*Water Resources Research*, doi:10.1002/2015WR017464, 2015)

—Lily Strelich, Freelance Writer

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Atmospheric Sciences

Endowed Chair (Associate/Full Professor) of Unconventional Energy

The Department of Earth, Atmospheric, and Planetary Sciences at Purdue University invite applications for the Steven and Karen Brand Chair in unconventional energy resources. Candidates with a core expertise in unconventional energy with a strong and consistent track record of applying this expertise to unconventional petroleum resources will be considered. Candidates with expertise including, but not limited to, unconventional exploration and production, tight reservoir characterization, geophysics and seismic data analysis, subsurface integration, hydraulic fracture mechanics, pore/fluid interactions, water and environmental issues, and enhanced oil and gas recovery are encouraged to apply. Excellence in and/or commitment to multi-disciplinary research and teaching is a requirement. It is expected that the candidate hired would significantly enhance Purdue's visibility and impact in this key area; increase opportunities for industry collaboration and grant funding; and inspire and train the next generation of leaders in the field.

This is an open-rank search; senior or mid-career scientists with academic, national laboratory, and industry background are all encouraged to apply. Applicant must hold a doctorate in an appropriate field; salary and rank are commensurate with qualifications and experience. The Department of Earth, Atmospheric, and Planetary Sciences, and the College of Science at Purdue embrace diversity and seek candidates who will create a climate that attracts students of all races, nationalities, and genders. We strongly encourage women and under-represented minorities to apply.

The department, in collaboration with other departments, has expertise in solid earth geophysics and crustal seismology, fracture mechanics, fluid flow in porous media, hydrogeology, clay mineralogy and surface chemistry, and basin analysis. The department has a long tradition of training students for careers in the petroleum industry and is part of a new multidisciplinary initiative at Purdue University aimed at addressing the energy needs of the country and is affiliated with the newly established Enhanced Oil Recovery Laboratory located in Discovery Park. Faculty members have a long history of working closely with and providing leadership to various Purdue University Discovery Park Centers (www.purdue.edu/DP). The successful applicant will conduct research, will advise graduate students, will teach undergraduate and graduate level courses, and will perform service. The successful applicant will be expected to work across these existing areas of Purdue expertise and build on them with a focus on unconventional resources. Applicants should have a vision for the design and execution of a cross-functional program that achieves the intended mission as described above.

Interested applicants should visit https://hiring.science.purdue.edu; submit a curriculum vitae, a research statement, a vision statement, a teaching statement, and complete contact information for at least 3 references. Review of applications will begin January 15, 2016, and continue until the position is filled. Questions related to this position should be sent to Drs. John Cushman or Ken Ridgway, Co-Chairs of the Search Committee (phone: 765-494-3258, email jcushman@purdue.edu or ridge@purdue.edu. Applications will be accepted until the position is filled.

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The Foster and Coco Stanback Postdoctoral Fellowship Global Environmental Science

The California Institute of Technology invites applications for a postdoctoral fellowship in global environmental science beginning in fall 2016. The intent of the program is to support innovative and creative early career scientists working in global environmental science, including areas such as biogeochemistry, glaciology, paleo-climatology, and the atmosphere and ocean sciences.

The fellowship is funded in part by an endowment provided by Foster and Coco Stanback. It carries an annual stipend of $62,000 plus a research expense fund of $5,000 and one-way travel costs to Pasadena. The duration of each appointment is normally two years, contingent upon completion of the Ph.D. degree and good progress in the first year. The Stanback Fellow will be hosted by one or more professors, who will also provide financial support in the second year. Fellows are eligible to participate in Caltech's benefit programs, including health and dental plans.

To apply online, please go here: https://applications.caltech.edu/job/stanback

Materials in support of an application should include curriculum vitae, list of publications, a one-page statement of research interests, and three letters of reference. To be eligible, candidates should have received their Ph.D. no earlier than April 1st, 2015 except in exceptional circumstances. All applications and references are due by Sunday, January 31, 2016.

Fellowship candidates will automatically be considered for other available postdoctoral positions at Caltech in their fields of interest.

If there are any questions during the application process, please contact us at marcia@gps.caltech.edu

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Biogeosciences

Postdoc - Software Development Framework Connecting Models, Remote Sensing Data, and Field Measurements

The California Institute of Technology (Caltech), Postdoctoral Scholars Program at the Jet Propulsion Laboratory (JPL) invites applications for a postdoctoral research position in JPL's Carbon Cycle and Ecosystems Group.

The research will support an exciting new decadal NASA program called the Arctic Boreal Vulnerability Experiment (ABoVE; above.nasa.gov). The Arctic-Boreal Region is being impacted by climate change more than anywhere else in the world, yet this region is the source of among the largest uncertainties to global climate projections. NASA has selected a suite of field-based teams to collect data on the ground linked to airborne and satellite observations, providing the necessary information to reduce uncertainty in Earth System Models. This project is unique within the ABoVE Program in that it aims to synthesize and integrate these data across a large suite of models to achieve the ultimate goal of uncertainty reduction. The Postdoctoral Scholar will build the framework for driving and evaluating terrestrial biosphere models with ABoVE data, evaluate the improvement to models, and publish science papers on the framework and results. Dr. Joshua Fisher, in JPL's Earth Science Section, will serve as JPL postdoctoral advisor to the selected candidate. The Postdoctoral Scholar will also work closely with the project team at the University of Maine and Northern Arizona University, the NASA ABoVE Program Office and Science Team, an international group of collaborating modelers, and JPL scientists and engineers. The appointee will carry out research in collaboration with the JPL advisor, resulting in publications in the open literature.

Candidates should have a recent PhD with a unique background combining a foundation in Computer Science/Software Engineering with an application to Earth's environment, preferably in terrestrial ecosystems. Candidates who have received their PhD within the past five years since the date of their application are eligible. Postdoctoral Scholar positions are awarded for a minimum of one-year period and may be renewed up to a maximum of three years.

Caltech and JPL are equal opportunity/affirmative action employers. Women, minorities, veterans, and disabled persons are encouraged to apply. The position will remain open until filled, with a desired (but not required) start date of March 2016. Please send a letter describing how this project fits with your background, a cv, and a list of references with contact info to: jbfisher@jpl.nasa.gov.

Max-Planck-Institut für Meteorologie

MAX-PLANCK-GESELLSCHAFT

The Max Planck Institute for Meteorology (MPI-M) is a multidisciplinary center for climate and Earth system research located in Hamburg, Germany. Within the department **"The Ocean in the Earth System"** (OES, director: Prof. Jochem Marotzke), we seek an outstanding candidate to fill the position of

a Group leader/research scientist (f/m, Ref. MPIM-W016)

in the area of

Using ocean observations to understand climate processes and to evaluate climate models

The exact subfield within this area is open; a non-exclusive list includes observations of ocean heat content; observations of ocean circulation via satellite altimetry, gravity measurements, or in-situ; or observations of surface exchanges via remote sensing. Depending on qualifications, the position will be filled at the research scientist level (within the Director's research group, co-led by Prof. Jochem Marotzke and Dr. Johann Jungclaus), or the successful candidate will establish his or her own research group within OES. As a group leader, he or she would have considerable flexibility to define his or her own research agenda within the strategic aims of OES, would be supported in acquiring extramural funds, would receive technical support for making observations, and would have access to PhD studentships from our graduate school IMPRS-ESM.

Requirements 1) PhD in physical oceanography, physical climate science, or a related field; 2) Outstanding research capability as demonstrated by peer-reviewed publications; 3) Experience in making and interpreting ocean observations, either in-situ or remotely sensed; 4) Strong motivation to establish a distinct research profile; 5) For appointment at group leader level, demonstrated research leadership or promise thereof, as well as willingness to engage in PhD education.

Experience in evaluating climate models is highly desired.

Employment conditions 1) The position is offered for up to five years, starting as soon as possible and with the possibility of renewal; renewal would be subject to performance and applicable conditions of employment. 2) Payment will be in accordance with German public service positions (TVoeD E14), including extensive social security plans. The conditions of employment, including upgrades and duration, follow the rules of the Max Planck Society for the Advancement of Science and those of the German civil service. 3) The Max Planck Institute for Meteorology seeks to increase the number of female scientist and encourages them to apply. Handicapped persons with comparable qualifications receive preferential status.

Selection criteria Candidates will be evaluated according to their qualifications and ability to fulfill the requirements outlined above.

How to submit your application for this post Please submit: 1) A cover letter; 2) A detailed curriculum vitae; 3) A one-page statement of research interests, accomplishments, and plans; 4) The names, addresses, and telephone numbers of three references by uploading the documents in our online Webtool:
https://s-lotus.gwdg.de/mpg/mhmt/perso/mpim_w016.nsf/application

Deadline for applying This vacancy has been opened **16 November 2015**. A first cut-off date for the collection of the applications is foreseen on **10 January 2016**. If the position is not filled, this vacancy announcement will be re-published indicating a second cut-off date.

Further information on this position For further information, please contact Professor Jochem Marotzke *(jochem.marotzke(at)mpimet.mpg.de)*.
Please do not forward your application to this email address; the applications need to be submitted through the online Webtool (see link above).

Hydrology

Tenure-Track Assistant Professor Position GROUNDWATER HYDROLOGIST University of Wyoming

The Department of Civil and Architectural Engineering at the University of Wyoming invites applications for a tenure-track faculty position in Groundwater Hydrology at the Assistant Professor level. We seek a candidate with the interest and abilit y to develop and sustain a nationally competitive research program. The successful candidate must hold an earned doctoral degree in Civil Engineering or in a closely related discipline by the position start date. Registration as a professional engineer or professional hydrologist are desirable but not required. The successful candidate must be able to teach courses in fluid mechanics, hydraulics, hydrology, and water resources engineering. Also, the successful candidate must have the demonstrated ability to develop an externally funded research program in groundwater hydrology.

This position will become part of a major research thrust in water resources at the University of Wyoming. Groundwater resources are of immense impo11ance to societal and ecological needs. Approximately half of Wyoming water resources are from groundwater, and subsurface resources provide critical water to agriculture, oil and gas development, and municipalities. There are tremendous research challenges in groundwater resulting from changing climate signals and human population patterns, and emerging techniques provide outstanding opportunities for groundwater hydrologists to better quantify the fate and transport of water in a changing west. We seek a groundwater hydrologist with experience in laboratory and field approaches for describing complex subsurface processes. Areas of specific interest include, but are not limited to, surface-groundwater interaction, unsaturated flow and contaminant transport.

As a member of the faculty of the Department of Civil and Architectural Engineering, the successful candidate will integrate his or her research with the goals of the new Wyoming Center for Environmental Hydrology and Geophysics (http://www.uwyo.edu/epscor/wycehg/) and provide academic support to the PhD program in Water Resources, Environmental Science and Engineering (http://www.uwyo.edu/wrese/).

UW faculty have access to world-class computational resources as described at: https://arcc.uwyo.edu/. The depat1ment is supported by 22 tenured or tenure-track faculty and offers ABET-accredited baccalaureate programs in both civil engineering and architectural engineering to approximately 300 undergraduate students. The department also offers graduate programs at the Masters and PhD levels to roughly 60 graduate students.

Laramie is a picturesque and friendly town offering a reasonable cost ofliving, good K-12 public schools and easy access to outdoor activities in the Rocky Mountain region. Additional information on the Department, College, and Laramie is available at: http://www.uwyo.edu/civil, http://ceas.uwyo.edu and http://www.laramie.org.

Applications must include: 1) a letter of application, 2) a curriculum vitae including a list of publications, 3) a statement of research interests, 4) a statement ofteaching interests, and 5) contact information for at least three references. Do not include supplemental information such as off-prints of papers, reference letters, or transcripts. Review of applications will begin 15 September 2015 and continue until the position is filled. The preferred start date for the position is January 2016. Submit applications in a single PDF file to: water_search@uwyo.edu.

The University ofWyoming is an Equal Employment Opportunity/Affirmative Action employer. All qualified applicants will receive consideration for employment without regard to race, color, religion, sex, national origin, disability or protected veteran status or any other characteristic protected by law and University policy. Please see: http://www.uwyo.edu/diversity/faimess. We conduct background investigations for all final candidates being considered for employment. Offers of employment are contingent upon the completion of the background check.

Tenure-Track Faculty Position, Civil and Environmental Engineering, Utah State University

The Department of Civil and Environmental Engineering at Utah State University is searching to fill a tenure-track faculty position in water management of irrigated systems (complete description go to https://usu.hiretouch.com/job-details?jobid=937) as part of a water-focused cluster hire involving multiple colleges within the University (https://caas.usu.edu/cwi/). All ranks (Assistant/Associate/Full Professor level) will be considered for this position. Applications will begin being reviewed on 12/2/15, but the position will remain open until filled

Ocean Sciences

The Marine Science Institute (University of California, Santa Barbara) seeks a PhD level postdoctoral fellow to contribute to studies of nutrient fluxes and exchanges from sediments into coastal waters near kelp forest ecosystems.

The position will involve hydrodynamic and biogeochemical field measurements and associated data analysis and modeling. The research is associated with an on-going NSF funded Long-Term Ecological Research (LTER) project and related work on coastal ecosystems (http://sbc.lternet.edu/). Salary and benefits will depend on academic background and experience. 100% time appointment for one year from start date with possibility for second year renewal. Start date is negotiable, but is anticipated by April 2016. Electronic applications (including a full CV, description of research interests and names and addresses of three references) should be sent to: https://recruit.ap.ucsb.edu/apply/JPF00623. Application review will begin January 15, 2016 and continue until position is filled. The department is especially interested in candidates who can contribute to the diversity and excellence of the academic community. The University of California is an Equal Opportunity/Affirmative Action Employer. All qualified applicants will receive consideration for employment without regard to race, color, religion, sex, national origin, or any other characteristic protected by law including protected Veterans and individuals with disabilities.

Solid Earth Geophysics

Tenure-Track Faculty Position in Geophysics (position number 198994, requisition number 1500158F)

The Department of Physics at New Mexico State University invites applications for a tenure-track faculty appointment in Computational Geophysics. Candidates with computational skills in seismology, crustal and mantle dynamics, and thermo-mechanical properties of rock systems are invited. A strong computational and physics background is required. The NMSU Physics Dept. offers Bachelor's degrees in Physics and Engineering Physics and Master's and Doctoral degrees in Physics and Geophysics. Current research areas in the department include high-energy nuclear and particle physics, solid-state/condensed-matter physics and materials science, optics, and geophysics. There are additional university strengths in Astronomy (helioseismology and planetary physics), Electrical and Computer Engineering, and Mechanical Engineering. The successful candidate is expected to initiate and maintain an active, externally funded research program, supervise graduate students, and to teach at both undergraduate and graduate levels. Appointment will be at the Assistant Professor level. A Ph.D. degree in Physics, Geophysics, or related field is required, and postdoctoral experience is highly desired.

Applications must be filed electronically at (http://jobs.nmsu.edu) and the deadline for applications is February 15, 2016. Applicants should attach a resume, a statement of research interests, a short description of the candidate's teaching philosophy and the names and addresses of at least three persons familiar with the candidate who are willing to provide letters of reference. The position is anticipated to start in Fall, 2016.

For further information or questions please contact the Head of the Search Committee, Prof. Tom Hearn, at thearn@physics.nmsu.edu. NMSU is an Equal-Opportunity/Affirmative-Action employer; Minorities, Females, Veterans, and those with a Disability are particularly encouraged to apply.

Space Physics

Postdoctoral Research Position in the Center for Space Environment Modeling, Department of Climate and Space Sciences and Engineering, University of Michigan

From: Ward Manchester (chipm@umich.edu)

The Center for Space Environment Modeling announces the opening of one postdoctoral position in Space Physics and Planetary Science, to work in development of numerical models describing the solar wind interaction with the Mars upper atmosphere/ionosphere. The candidate's primary job will be to simulate the self-consistent interaction of the Mars upper atmosphere/ionosphere with ICME events, compare the Mars system model responses to available Mars data sets (e.g. MAVEN, MGS, Mars Express), and determine the ion loss rates to estimate historic losses affecting atmospheric evolution.

Applicants should have completed a Ph.D. in Space Science or Engineering or a closely related field and have had prior experience in developing and running numerical models of planetary space environments. Requirements also include extensive computational skills including working knowledge of Fortran95, Perl, Python and/or IDL programming. Experience handling and analyzing scientific data from space based instruments or space missions such as MAVEN is strongly valued. The initial appointment will be for one year, with the possibility of renewal for up to four years, contingent on performance and availability of research funds. Starting salary will be in the range between $50,000 and $55,000 per annum dependent on qualifications and prior experience. Review of applications will begin immediately. The University of Michigan is an equal opportunity employer.

Applications should include a curriculum vitae, publication list, short description of research interests, and names and contact information of two individuals who can provide letters of reference.

Applications and inquiries should be directed to: Associate Research Professor Ward Manchester, Space Research Laboratory, Department of Climate and Space Sciences and Engineering, 2455 Hayward Drive, Ann Arbor MI 48105. Phone 734 647 3475. Fax 734 615 9723, Email: chipm@umich.edu and cc Stephen Bougher Email: bougher@umich.edu

Faculty Positions in EARTH SCIENCE AND ENGINEERING PROGRAM

جامعة الملك عبدالله للعلوم والتقنية
King Abdullah University of Science and Technology

The Physical Science and Engineering (PSE) Division (http://pse.kaust.edu.sa) at King Abdullah University of Science and Technology (KAUST) invites qualified applicants to apply for faculty positions at all ranks (Assistant, Associate and Full Professor) in the Earth Science and Engineering (ErSE) program.

KAUST is an international, graduate research university dedicated to advancing science and technology through interdisciplinary research, education, and innovation. Located on the shores of the Red Sea in Saudi Arabia, KAUST offers superb research facilities including core labs, generous assured research funding, and internationally competitive salaries.

The university encourages fundamental and goal-oriented research to address the world's pressing scientific and technological challenges related to the sustainability of water, food, energy, and the environment.

The science produced in PSE focuses on understanding, modeling and manipulating matter at all scales (nano, meso and macroscopic levels), in all forms (bulk, thin films, divided colloids, fluid flows, the earth as system, etc.) and in interaction with external stimuli (light, heat, fluids, stresses, etc.).

The ErSE program currently has eleven full-time faculty members, about 42 postdoctoral fellows and research scientists and more than 64 graduate students. Research areas include: applications of modern computational methods to study geophysical problems associated with the atmosphere and/or ocean circulation, earthquakes, oil exploration, reservoir modeling and subsurface phenomena. These areas are enhanced through close collaboration with some of the best geophysical and meteorological centers in the world, and through KAUST's advanced central research facilities, including supercomputing and scientific visualization. A research center specifically devoted to Upstream Petoleum Engineering (UPERC) has recently been created.

More information about the ErSE program and research activities is available at: http://erse.kaust.edu.sa.

The ErSE program at KAUST has open faculty positions at Assistant, Associate or Full Professor rank in experimental geophysics, in particular in the fields of:

Atmospheric aerosols
Boundary layer and air-sea interaction
Structural and/or sedimentary geology
Carbonate reservoirs: formation and properties for UPERC
Multiscale flow and coupled processes for UPERC Petrophysics and wireline logging for UPERC
Geophysics and rock physics for UPERC
Robust reservoir simulation with flow coupling for UPERC

Applicants should have a proven track record in establishing a high-impact research program, and should show commitment to high-quality teaching at the graduate level.

To learn more about the PSE Division and complete the online application form, visit **http://apptrkr.com/705569**

Application requirements include the following:

- Updated curriculum vitae with a full list of publications
- Statement of research
- Statement of teaching interests
- Contact details of at least four potential referees

Applications received by January 31, 2016 will receive full consideration but positions will remain open until filled.

Interdisciplinary/Other

Assistant Professor in Tectonics/Structural Geology, Department of Geology, University of Maryland, College Park.

The Department of Geology at the University of Maryland invites applications for a tenure-track assistant professor in Tectonics/Structural Geology, broadly defined. Possible research areas of interest include, but are not limited to: active tectonics and natural hazards, basin analysis, climate-tectonics interactions, crustal evolution, geodesy, microtectonics, orogenesis, planetary geology, and tectonophysics. The appointee will be expected to develop and maintain an active, externally funded research program that will involve both graduate and undergraduate students, and to participate fully in teaching at all levels, including structural geology. We particularly encourage applications from those who integrate across traditional disciplinary boundaries both within the Department of Geology (http://www.geology.umd.edu) and throughout the College of Computer, Mathematics, and Natural Sciences (http://www.cmns.umd.edu). Candidates from underrepresented groups are encouraged to apply.

A Ph.D. in Geology or a related discipline is required at the time of appointment. The appointment may begin as early as August 1, 2016. Applications should be submitted online at http://ejobs.umd.edu/postings/38311 and should include the following: a letter of application stating research and teaching goals; a complete CV; and contact information for three (3) professional references. Review of applications will begin in January 2016, and will be ongoing until the position is filled.

The University of Maryland, College Park, an equal opportunity/affirmative action employer, complies with all applicable federal and state laws and regulations regarding nondiscrimination and affirmative action; all qualified applicants will receive consideration for employment. The University is committed to a policy of equal opportunity for all persons and does not discriminate on the basis of race, color, religion, sex, national origin, physical or mental disability, protected veteran status, age, gender identity or expression, sexual orientation, creed, marital status, political affiliation, personal appearance, or on the basis of rights secured by the First Amendment, in all aspects of employment, educational programs and activities, and admissions.

Coastal Wetland Resilience

As part of a growing interest in coastal resilience and climate change, a full-time tenure-track position is available at the University of Maryland Center for Environmental Sciences, Horn Point Laboratory. We seek applicants who take a quantitative systems science approach to integrating plant ecology and feedbacks to landscape dynamics in estuarine and coastal wetland environments with the broad application goal of increasing coastal community resilience. Relevant research areas include, but are not limited to, the following: (1) influence of feedbacks among plants, animals and geomorphologic processes on wetland ecosystem structure and function; (2) resilience of coupled wetland ecological and geomorphologic processes to climate change and human impacts; and (3) application to restoration and management of coastal wetlands. Candidates with strong field, experimental, modeling, and/or remote sensing skills are encouraged to apply.

The candidate should have a doctorate in a relevant field, at least two years of postdoctoral experience and evidence of previous success acquiring extramural funding. Candidates at all career stages are encouraged to apply. The successful candidate will be expected to maintain a vibrant research program with extramural funding and contribute to teaching and student mentoring at the graduate level.

The application which should include separate statements of research and teaching interests, as well as curriculum vitae that includes funding history, previous teaching and supervising graduate students, publications, and the names and contact information for three academic references should be e-mailed to: facultyposition@umces.edu. Review of applications will begin on February 15, 2016.

UMCES is an EEO/AA employer. Individuals with disabilities, veterans, women and minorities are encouraged to apply.

Assistant/Associate Professor of Microbial Biogeochemistry

The Department of Soil, Water and Environmental Science (SWES) at the University of Arizona seeks a dynamic individual to initiate a research and teaching program at the interface of soil microbial ecology and biogeochemistry. Applicants are sought who use contemporary techniques such as genomics, bioinformatics, isotope geochemistry, or high resolution imaging and spectroscopy, to study microbial communities and activities, and their interactions with biogeochemical processes in earth surface systems (ecosystems, soil, rock, water). Potential research foci may include (but are not limited to): plant-soil-microbe relations; nutrient dynamics and rhizosphere processes; mineral and organic matter transformations; and coupled microbial-biogeochemical processes, ranging from molecular to watershed scales. The candidate will teach an undergraduate course each year and a

graduate course in a related area of specialization, contribute to student mentoring, and help to develop innovative approaches to enhance student engagement, increase diversity, and expand collaborations with community and business partners.

The SWES department comprises a cross-section of faculty, staff, and students with unparalleled capacity to address emerging environmental issues of local to global significance, including climate change, contaminant remediation, and the sustainable management of land and water resources. Outstanding research opportunities exist at the University of Arizona, with a strong culture of interdisciplinary scholarship among faculty in the School of Earth and Environmental Sciences (http://www.sees.arizona.edu/), the School of Plant Sciences, the Department of Ecology and Evolutionary Biology, the Mel and Enid Zuckerman School of Public Health, and Biosphere 2.

Qualifications:

Minimum qualifications include a Ph.D. in microbiology, soil science or geoscience, biogeochemistry, or a closely related field. Postdoctoral experience is preferred. Applications from candidates with an interest in collaborative research are preferred, as are those from individuals who would bring novel microbial and/or biogeochemical approaches and techniques to bear on environmental systems. This is a tenure/tenure-eligible position and will have a 70/30 split between research and teaching. As an equal opportunity and affirmative action employer, the University of Arizona recognizes the power of a diverse community and encourages applications from individuals with varied experiences, perspectives and backgrounds, and who have experience with a variety of teaching methods and curricular perspectives.

About the University of Arizona:

The University of Arizona is the state's land-grant university and the Agricultural Experiment Station and Extension programs are housed in the College of Agriculture and Life Sciences (http://cals.arizona.edu/main/), which SWES is a part of. The UA is recognized as a global leader for research with a diverse working environment, nationally recognized work/life program, and a competitive benefits package. The UA is located in the heart of Tucson, a diverse and vibrant community, with a growing population, excellent recreational opportunities, and favorable economic climate. Explore Tucson and UA at http://whyua.arizona.edu/.

Application Instructions:

More information on the position and complete application instructions may be found at the UA Human Resources link: https://uacareers.com/postings/6969. Formal review of applications will begin 2/15/16 and continue until the position is filled.

DIRECTOR – Byrd Polar and Climate Research Center 12/01/2015

Through 55 years of excellence, the Byrd Polar and Climate Research Center (BPCRC) of The Ohio State University, has earned an international reputation as one of the premier polar and alpine research and teaching centers globally with an expanding focus on global climate and environmental issues. Over the years the scope of research at BPCRC has broadened significantly to encompass civil and environmental engineering, earth sciences, environmental sciences, glaciology, meteorology, oceanography, paleoclimatology, and remote sensing.

BPCRC's goal is to continue the pursuit of excellence in existing research and teaching programs and to increase national and international contributions to the understanding and knowledge in areas such as climate variability, detecting and interpreting changes in modern physical and biogeochemical systems, and predicting future climatic and environmental changes and the associated benefits and/or consequences for society. To achieve these goals, the Center aspires to grow and expand its research foci to include a more global perspective.

These scientific foci are complemented by a very active archival research program that preserves important collections such as the papers of Admiral Richard E. Byrd, Sir Hubert Wilkins, and Dr. Frederick Cook, as well as outreach activities through BPCRC's Education and Outreach Program that include tours and hands-on activities, workshops for educators and students, seminar series and other special programs. The BPCRC also offers diverse and often unique learning experiences for OSU undergraduates, graduates and Postdocs in the laboratory and the field. More information about all of BPCRC's research programs and related activities can be found on the BPCRC website http://bpcrc.osu.edu/.

BPCRC is seeking an extraordinary individual with vision who will provide the leadership necessary to strengthen existing research programs, develop research in new areas, encourage collaborative activities within the center and university, foster relations with current funding agencies (NSF, NASA, NOAA, ONR, etc.), and actively explore new funding opportunities. Other equally important expectations for the successful candidate are to facilitate outreach activities nationally and within the university and local community. Finally this individual is expected to maintain a vigorous and high-profile research program. The successful candidate will have an established national and international stature in a relevant Earth system science field that is based on an outstanding record of recent publications and competitive research funding. A faculty appointment for the successful

candidate will be made at the appropriate level within one of BPCRC's affiliated departments (e.g., Chemistry; Civil and Environmental Engineering and Geodetic Science; Environmental Engineering; Evolution, Ecology and Organismal Biology; Geography; School of Earth Sciences).

The BPCRC was established in 1961 and is the oldest active research center at OSU, and takes great pride in setting an example of excellence to all who interact with the center, as well as instilling the feeling of enduring comradery amongst all members, both present and past. In addition, the Ohio State University is consistently ranked among the nation's best public universities and is home to some of the finest faculty and staff who are known internationally for their academic and research credentials. Columbus, Ohio is a progressive, cosmopolitan city of ~1 million people. It hosts an array of diverse, friendly neighborhoods, attractions and activities and access to outstanding health care facilities. Please visit http://columbusregion.com and http://www.glpublishing.com/digitaleditions/vgfw15/index.html to learn more about Columbus.

To apply, send a curriculum vitae, a statement of research interest, a description of relevant research and management experience, and the names of three references to: Professor Lonnie G. Thompson, Chair, Search Committee for BPCRC Director, Byrd Polar and Climate Research Center, The Ohio State University, 108 Scott Hall, 1090 Carmack Rd., Columbus, OH 43210 USA. The BPCRC search committee will begin reviewing applications immediately and continue until a suitable candidate is found. The Ohio State University is an equal opportunity/affirmative action employer. Women and minority candidates are strongly encouraged to apply. Final candidates will be required to complete a background screening.

DIRECTOR – Kansas Geological Survey –The University of Kansas, Lawrence.

Full-time position serving as the Director of the Kansas Geological Survey (KGS) and State Geologist. Must develop and articulate a vision of KGS programs, understand the concept of serving Kansas through high-quality research in the applied geosciences, and embrace a collegial leadership style. Requires doctorate in the geosciences with 10 years professional experience, 3 years administrative experience, national recognition in geoscience research, excellent communication skills, knowledge of natural resources and the environmental aspects of their use, and demonstrated ability to deal with natural-resource policy issues.

The KGS is a research and service division of the University of Kansas (KU). Created in 1889, the Survey studies the geology of Kansas, develops new techniques for exploring and analyzing geologic data, and produces and disseminates maps, reports, and scientific papers. Among the premier earth-science research and service institutions in the U.S., the KGS has an annual state budget of $5.8 million, a fiscal year 2014 grant and contract budget of $2 million, and employs more than 115 researchers, support staff, and students engaged in a variety of disciplines. Staff collaborate extensively with faculty and students in academic departments at KU.

Full announcement and application info. at www.kgs.ku.edu/General/jobs.html. Review will begin January 25, 2016, position open until filled. For further information contact Jim Butler (jbutler@kgs.ku.edu) or Greg Ludvigson (gludvigson@kgs.ku.edu). KU is an EO/AAE, http://policy.ku.edu/IOA/nondiscrimination.

Post-Doctoral Fellowships: Dept. of Earth, Ocean and Atmospheric Science, Florida State University

The Department of Earth, Ocean & Atmospheric Science (EOAS) at Florida State University seeks candidates for two postdoctoral positions to conduct supervised research and teaching duties in the areas of solid Earth dynamics, isotope geochemistry, or arctic carbon cycling. These two-year positions are jointly supported by the College of Arts & Sciences and by faculty research grants. The positions are intended to better prepare future faculty by combining state-of-the-art research programs with classroom teaching experience for the candidates, and will involve two semesters of teaching, including one semester where the candidate will serve as the instructor of record for an undergraduate course. Fellows will work under direction of FSU faculty to support funded research programs (see below). Additionally, they will develop classroom teaching skills during one semester of each year, first under supervision and, during the second year, as instructors of record for an undergraduate class details of which are provided below. Fellows will be eligible to participate in the Preparing Future Faculty program at FSU (PFF). Research programs and instructional mentors seeking fellows include the following:

"Insights into the volatile budget in the Earth's interior using high pressure experiments, geochemical analysis, and numerical simulations. [see online info].

"Applying novel geochemical methods (e.g. novel stable metal isotopes) to the sedimentary record to trace the redox evolution throughout Earth history. [see online info].

"Researching carbon storage and flux in Arctic permafrost soils and peatlands from the arctic to the tropics [see online info].

Eligible candidates must hold a PhD in chemical oceanography, geochemistry or mineral physics related to the three areas of interest described above, at the time of appointment. Salary is $45,000 per annum, participation in state health plans is covered and $1,500 towards the purchase of a computer may be requested. The Florida State University is an equal opportunity, affirmative action employer and women, minorities, and individuals with disabilities, are strongly encouraged to apply. To apply, respond to the listing for Postdoctoral Associate, Earth, Ocean and Atmospheric Science at http://jobs.fsu.edu. Additional inquiries may be addressed to EOAS-PostDoc@ocean.fsu.edu. Review of applications will begin February 26, 2016, and appointment terms will begin for the fall semester 2016.

Student Opportunities

EMPOWER-Education Model Program on Water-Energy Research-is a new National Science Foundation Research Traineeship (NRT) interdisciplinary graduate training program at Syracuse University.

We are seeking applications from individuals interested in pursuing graduate study and professional training within the "water-energy nexus." For more information about EMPOWER, please visit our website at empower.syr.edu or contact Deanna McCay at dhmccay@syr.edu.

NASA Student Research Opportunity – Summer 2016

The NASA Airborne Science Program invites highly motivated advanced undergraduates who will be rising seniors in summer 2016 to apply for participation in the 8th annual NASA Student Airborne Research Program (SARP 2016). The purpose of the Student Airborne Research Program is to provide students with hands-on research experience in all aspects of a major scientific campaign, from detailed planning on how to achieve mission objectives to formal presentation of results and conclusions to peers and others. Students will work in multi-disciplinary teams to study surface, atmospheric, and oceanographic processes. Participants will fly onboard the NASA DC-8 and assist in the operation of instruments to sample and measure atmospheric solar radiation, gases and aerosols. They will also use remote sensing data collected during the program from the NASA ER-2 high-altitude research aircraft to image land and water surfaces in multiple spectral bands. Along with airborne data collection, students will participate in taking measurements at field sites. Each student will complete an individual research project from the data collected.

Outstanding faculty and staff for this program will be drawn from sev-

eral universities and NASA centers, as well as from NASA flight operations and engineering personnel.

The eight-week program begins June 12, 2016 and concludes August 5, 2016.

Instrument and flight preparations, and the research flights themselves, will take place during the first two weeks of the program at NASA's Armstrong Flight Research Center, in Palmdale, CA. Post-flight data analysis and interpretation will take place during the final six weeks of the program at the University of California, Irvine.

SARP participants will receive a $5,000 stipend. They will also receive a travel allowance as well as free housing and local transportation during the 8-week program.

Applicants must be US citizens attending a US college or university majoring in a STEM discipline.

The application deadline is Wednesday February 2, 2016.

Apply here: www.nserc.und.edu/sarp/sarp-2016/

Email questions to the SARP Project Manager, Dr. Emily Schaller, at: SARP2016@nserc.und.edu

Follow us on Facebook: facebook.com/nasasarp

Ph.D. and MS Student Opportunities in Geological Sciences at Case Western Reserve University.

Students with backgrounds in geology, physics, engineering and related fields are encouraged to apply for our graduate programs in Earth, environmental and planetary sciences. Financial assistance is available. For more information, see http://geology.case.edu or contact eeps-gradinfo@case.edu

PhD Fellowships in Hydrologic Sciences available at the University of Nevada, Reno and Desert Research Institute

The Graduate Program of Hydrologic Sciences at the University of Nevada, Reno and the Desert Research Institute seeks PhD candidates in hydrology and hydrogeology to fill graduate teaching and research assistant positions beginning in Fall 2016. Three year research fellowships are available for a wide range of topics, including effects of halophytic plants on soil quality; climate patterns and tree rings; groundwater residence times and aquatic ecology of springs; snow ecohydrology; and Nevada water resources. Details are available at http://www.hydro.unr.edu/research/research_funding.aspx.

PhD Fellowships in Remote Sensing are available immediately in Virginia Tech's Interdisciplinary Graduate Program.

Remote Sensing is an interdisciplinary field which is evolving rapidly to address a wide range of scientific and societal problems. Virginia Tech's Remote Sensing graduate program spans nine departments in five separate colleges and covers all aspects of Remote Sensing, including engineering, theory, data analysis, applications, and policy. Students in the program pursue a Ph.D. in a core discipline in their home department while taking additional interdisciplinary courses which count toward a Remote Sensing Certificate. Interested applicants are encouraged to visit our website (http://rsigep.frec.vt.edu/) to learn more about the curriculum, specific research themes, the application process, and how to communicate with prospective advisors. General questions can be directed to rs_igep@vt.edu.

PhD in Climate Decision Making through EPP at Carnegie Mellon.

We seek PhD students with technical backgrounds to address 1) public understand and perceptions of GHGs, climate and low emission energy portfolios; 2) decarbonizing the energy system; 3) future of nuclear; and 4) risks of dead ends in scaling up climate policies. See: www.epp.cmu.edu and http://CEDMcenter.org. Contact: ebass@cmu.edu.

PhD Student Opportunity in Hydrology, Washington State University

Four year RA available for student to work with an interdisciplinary team to understand the interactions between drought, forest management, and wildfire on forest ecosystem resilience. Studentsexperienced with Linux/programming and/or ecohydrology will be competitive. The student will be co-advised by Jennifer Adam (WSU} and Christina Tague {UCSB}. Interested students should contact jcadam@wsu.edu for more information. Fall semester applications to WSU are due on 10 January for priority consideration.

The Jonathan O. Davis Scholarship

Supports graduate students working on the Quaternary geology of the Great Basin. The national scholarship is $7,500 and the University of Nevada, Reno stipend is $7,500. The national scholarship is open to graduate students enrolled in an M.S. or Ph.D. program at any university in the United States. The Nevada stipend is open to graduate students enrolled in an M.S. or Ph.D. program at the University of Nevada, Reno. Details on application requirements can be found at: http://www.dri.edu/GradPrograms/Opportunities/JonathanDavis. Applications must be post-marked by February 17, 2016. Proposals will not be returned. Applications should be addressed to: Executive Director Division of Earth and Ecosystem Sciences, Attn: Davis Scholarship, Desert Research Institute, 2215 Raggio Parkway, Reno NV 89512

Postcards from the Field

Getting Ready for the Moon, Mars, and Beyond…

This bizarre lava field, resulting from very recent eruptions (2000–15,000 years ago), is part of more than 60 flows at Craters of the Moon (COTM) National Monument and Preserve in Idaho. A team of 35 participants from all over the country and abroad converged at COTM in early August this year for a planetary analogue field trip. A rich suite of scientific investigations was carried out including in situ chemistry, mineralogy, aerial imaging, hyperspectral scanning, and high resolution topographic survey.

Here one of the teams is carrying out a differential GPS survey that will allow measurements of surface roughness with data collected every 15 centimeters!! The arrow in the image points to one of the cones (among many) marking the survey transect. The team braved through several miles to cover many such transects.

This field trip was part of two NASA supported projects: Field Investigations to Enable Solar System Exploration (FINESSE) and Biologic Analog Science Associated with Lava Terrains (BASALT).

Deepak Dhingra
University of Idaho (on behalf of the FINESSE & BASALT Teams)

View more postcards at:
http://americangeophysicalunion.tumblr.com/tagged/postcards-from-the-field.

AGU CHAPMAN CONFERENCE

Plan to Attend a Chapman in 2016

Chapman Conference on the Slow Slip Phenomena

21–25 February
Ixtapa, Guerrero, Mexico

Chapman Conference on Currents in Geospace and Beyond

22–27 May
Dubrovnik, Croatia

Chapman Conference on Emerging Issues in Tropical Ecohydrology

5–9 June
Cuenca, Ecuador

chapman.agu.org

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2016 Nominations Open 15 January

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New Union Awards for 2016

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William Kaula Award

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